

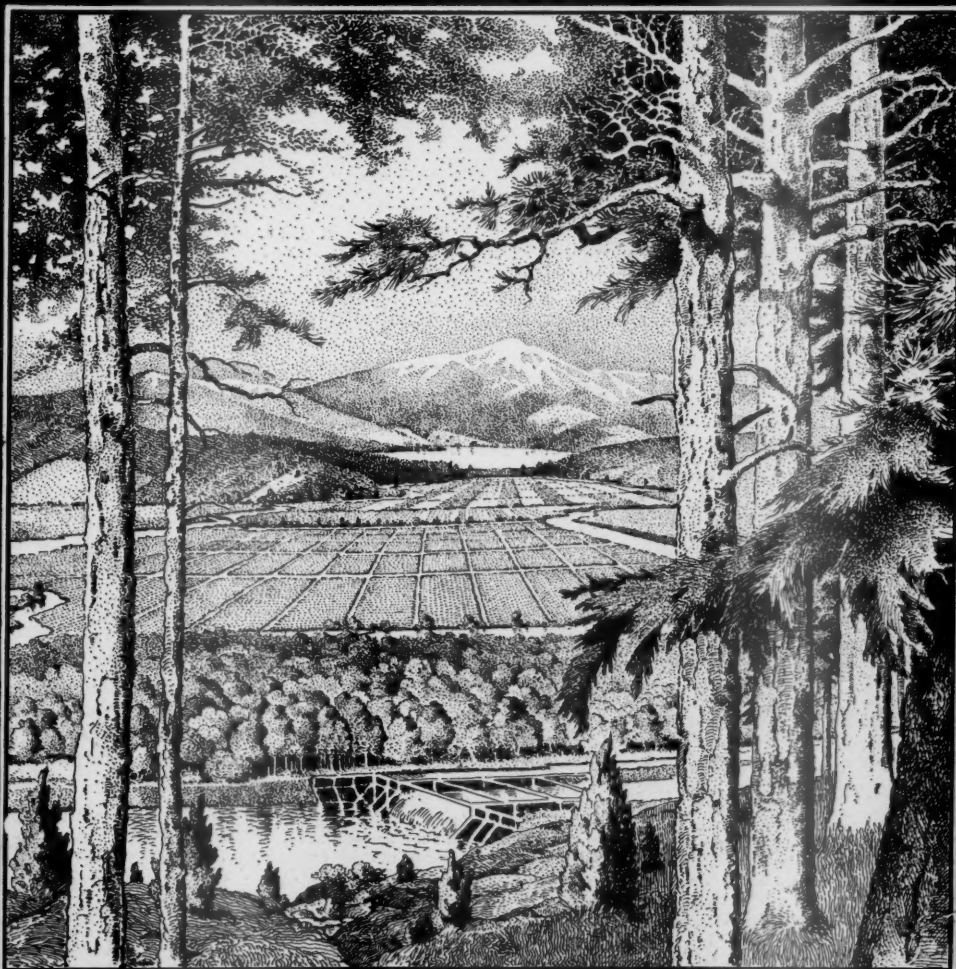
EFFECT OF FOREST COVER UPON STREAM FLOW.

Vol. XI—No. 6

JUNE, 1905

\$1.00 a Year; 10 cts. a Copy

FORESTRY & IRRIGATION



510 Twelfth Street Northwest, Washington, D. C.

THIRD ANNIVERSARY OF THE RECLAMATION ACT.

The
WORKS
of

THEODORE ROOSEVELT

Our
Sports-
man
President

FREE — TO — FIELD AND STREAM
Subscribers of

The Wilderness Hunter (1 vol.)

"Written by a mighty hunter, also a naturalist as well as a sportsman, a close observer as well as a sure shot."

Hunting the Grisly and Other Sketches (1 vol.)

Hunting Trips of a Ranchman (1 vol.)

"Covering ranching in the Bad Lands and hunting large game and waterfowl."

Hunting Trips on the Prairie and in the Wilderness (1 vol.)

"These sketches are not merely interesting as graphic pictures of hunting life, but have a historic value in describing a condition of things now rapidly passing away in the region of the prairies and the Rocky Mountains."

American Ideals (1 vol.)

"These essays are written on behalf of the many men who do take an actual part in trying practically to bring about the conditions for which we somewhat vaguely hope."—*From the Preface.*

Administration—Civil Service (1 vol.)

"The essays in this volume possess a special interest for the voters of to-day, in that they set forth the author's theories of citizenship and of administration."

The Naval War of 1812 (2 vols.)

The Winning of the West (6 vols.)

"The six volumes presented in this history, while each is complete in itself, comprise together a picturesque and comprehensive narrative of the early history of the great States of the Middle West and of the Southwest."

Our Attractive Offer

Every man, woman, and youth of red blood wants FIELD AND STREAM after reading one or more numbers, and every American will want at least some of the above books.

The subscription price of FIELD AND STREAM is \$1.50 per year. The magazine is interesting and healthfully inspiring to every member of the family circle or fireside. Its monthly visit is like a draught of pure air. The timely articles on the "How, When and Where" of sport with *Rod, Gun, Dog, Camera, Canoe, etc.*, are invaluable alike to novice or expert. An instructive series of articles is now running entitled "Camping and Woodcraft," written by Horace Kephart; also, just beginning, one on "Game Preserves in America," covering the most approved methods of introduction, propagation, etc., by the noted authority, Dwight W. Huntington.

Each year's subscription, renewal, or continuation of subscription, costing \$1.50, entitles the sender to a free choice of *any one volume*; two years (\$3.00) to two volumes, and so on up to any number wanted. To those who wish the complete set without prolonging their subscription for fourteen years or securing the subscriptions of others, we offer the complete set of 14 volumes and a three years' term of subscription for \$10.

These books are published by one of the highest class firms in America and are exceedingly neat and compact in form, 16mo, cloth bound, with frontispiece. All are uniform in size and binding. We guarantee that they will please or money refunded. All postage or express charges *prepaid by us*. *We will only furnish these books with above subscription offer. THE SUPPLY IS LIMITED! DO NOT DELAY!*

Mention this publication and address

FIELD AND STREAM

35 West 21st St.
New York

"America's Magazine for Sportsmen"

15 Cents a Copy on all News Stands

In writing advertisers kindly mention FORESTRY AND IRRIGATION

SCHOOLS & COLLEGES

Harvard University The Lawrence Scientific School

offers four year courses of study leading to the degree of S. B. in Civil, Mechanical, and Electrical Engineering, Mining and Metallurgy, Architecture, Landscape Architecture,

Forestry

Chemistry, Geology, Biology, Anatomy and Hygiene (preparation for medical Schools), Science for Teachers, and a course in General Science. For the catalogue and information, address J. L. LOVE, 16 University Hall, Cambridge, Mass.

N. S. SHALER, *Dean.*

Accurate estimates of standing timber, valuation surveys and working plans made, and expert advice on any logging, lumbering, or forestal proposition furnished by

C. A. SCHENCK & CO., Biltmore, N. C.
Consulting Forest Engineers.

Michigan Agricultural College

offers a full four-year course in
FORESTRY

Course in successful operation since 1902.

For information address E. E. BOGUE, Professor
Agricultural College Michigan.

California, Alta, Placer County

AGASSIZ HALL

is a boys' Preparatory School in the Sierra Nevada Mountains. Its boys are encouraged to ride, row, swim, fish, hunt, trap, snowshoe as out-of-school aids toward developing healthy manhood

THE University of the South Sewanee, Tennessee

DEPARTMENTS

Academic
Theological
Law

Medical
Pharmaceutical
Preparatory

The University of the South is situated in the center of its woodland domain of 10,000 acres on the summit of the Cumberland Mountains, 2,000 feet above sea level.

Open from March to December, the academic year being divided into three terms. Students from other Universities may attend the summer session, July 3 to September 26, in any department.

The University domain is being lumbered in a scientific manner under the direction of the Bureau of Forestry, U. S. Department of Agriculture, and an unusual opportunity is afforded for the preliminary study of forestry. Sewanee presents an exceptionally attractive field for the study of geology, and forest and field botany.

For further information address

THE VICE-CHANCELLOR



**NORTH
WEST**
AND
NORTH-WEST
VIA
**THE
NORTH-WESTERN
LINE**

Fast through train service to all points from Chicago, Milwaukee and Peoria on the East, to Omaha, Denver, the Black Hills, Salt Lake City and the Pacific Coast on the West, and northward to St. Paul, Minneapolis, Duluth, Superior, Ashland, Marquette and Sault Ste. Marie.

The Best of Everything.

W. B. Kniskern,
P. T. E.
Chicago, Ill.

NW371

In writing advertisers kindly mention FORESTRY AND IRRIGATION.

... THE ...
American Forestry Association

President—HON. JAMES WILSON,

SECRETARY OF AGRICULTURE.

The American Forestry Association was organized in 1882, and incorporated in January, 1897. It now has nearly three thousand members, residents of every State in the Union, Canada, and foreign countries. It has at all times been active in promoting measures tending toward the proper utilization of the forests and their protection from destruction by fires and wasteful use.

The objects of this Association are to promote :

1. A business-like and conservative use and treatment of the forest resources of this country ;
2. The advancement of legislation tending to this end, both in the States and the Congress of the United States, the inauguration of forest administration by the Federal Government and by the States ; and the extension of sound forestry by all proper methods ;
3. The diffusion of knowledge regarding the conservation, management, and renewal of forests, the proper utilization of their products, methods of reforestation of waste lands, and the planting of trees.

The Association desires and needs as members all who are interested in promoting the objects for which it is organized—all who realize the importance of using the natural resources of the country in such a manner as not to exhaust them, or to work ruin to other interests. In particular it appeals to owners of wood-lands, to lumbermen and foresters, as well as to engineers, professional, and business men who have to do with wood and its manifold uses, and to persons concerned in the conservation of water supplies for irrigation or other purposes.

The American Forestry Association holds annual and special meetings at different places in the country for the discussion and exchange of ideas, and to stimulate interest in its objects. *Forestry and Irrigation*, the magazine of authority in its special field, is the official organ of the Association, and is sent free to every member monthly. Its list of contributors includes practically all persons prominent in forest work in the United States, making it alone worth the cost of annual membership in the Association.

The annual dues are, for regular members, \$2.00, for sustaining members, \$25.00 ; life membership is \$100, with no further dues. Any person contributing \$1,000 to the funds of the Association shall be a Patron.

H. M. SUTER, *Secretary*.

Address: P. O. Box 356, Washington, D. C.

THE American Forestry Association

OFFICERS FOR 1905

President

Hon. JAMES WILSON, Secretary of Agriculture

First Vice-President, JAMES W. PINCHOT, Washington, D. C.

Recording Secretary

EDWARD A. BOWERS, New Haven, Conn.

Corresponding Secretary

H. M. SUTER, Washington, D. C.

Treasurer, OTTO LUEBKERT, Washington, D. C.

Directors

JAMES WILSON

WILLIAM L. HALL

OTTO LUEBKERT

GEORGE P. WHITTLESEY

HENRY S. GRAVES

B. E. FERNOW

F. H. NEWELL

GIFFORD PINCHOT

EDWARD A. BOWERS

GEORGE K. SMITH

WILLIAM S. HARVEY

Vice-Presidents

Sir H. G. Joly de Lotbiniere, Victoria, B. C.

Charles C. Georgeson, Sitka, Alaska.

John L. Kaul, Birmingham, Ala.

B. A. Fowler, Phoenix, Ariz.

T. P. Lukens, Pasadena, Cal.

W. G. M. Stone, Denver, Col.

Austin F. Hawes, New Haven Conn.

Henry M. Canby, Wilmington, Del.

John Joy Edson, Washington, D. C.

Elihu Stewart, Ottawa, Ont.

Chas. H. Herty, Green Cove Springs, Fla.

R. B. Reppard, Savannah, Ga.

J. T. Pence, Boise, Idaho.

Chas. Deering, Chicago, Ill.

W. H. Freeman, Indianapolis, Ind.

Hugh P. Baker, Ames, Iowa.

George W. Tincher, Topeka, Kansas.

S. C. Mason, Berea, Ky.

Lewis Johnson, New Orleans, La.

John E. Hobbs, North Berwick, Me.

Edward L. Mellus, Baltimore, Md.

Alfred Akerman, Boston, Mass.

Filibert Roth, Ann Arbor, Mich.

Samuel H. Green, St. Anthony Park, Minn.

William Trelease, St. Louis, Mo.

Charles E. Beasey, Lincoln, Neb.

Frank W. Rollins, Concord, N. H.

John Gifford, Princeton, N. J.

William F. Fox, Albany, N. Y.

C. A. Schenck, Biltmore, N. C.

Wm. R. Lazenby, Columbus, Ohio.

S. C. Bartrum, Roseburg, Oregon.

William A. Little, Perry, Okla.

J. T. Rothrock, West Chester, Pa.

George Peabody Wetmore, Newport, R. I.

George H. Whiting, Yankton, S. D.

Wm. L. Bray, Austin, Texas.

Luke Lea, Nashville, Tenn.

George L. Swendsen, Salt Lake City, Utah.

George Aitken, Woodstock, Vt.

D. O. Nourse, Blacksburg, Va.

Thomas L. Burke, Seattle, Wash.

A. D. Hopkins, Morgantown, W. Va.

E. M. Griffith, Madison, Wis.

Jos. M. Carey, Cheyenne, Wyoming.

Wm. Little, Montreal, Quebec.

Geo. P. Ahern, Manila, P. I.

Wm. R. Castle, Hawaii.

J. H. McLeary, San Juan, P. R.

Annual Dues, \$2. Life Membership, with exemption from further dues, \$100.

Sustaining Membership, \$25 a year

FORESTRY AND IRRIGATION is the official organ of the Association,
and sent regularly to all members

APPLICATION FOR MEMBERSHIP

To Mr. H. M. SUTER,

Secretary American Forestry Association

Box 356, Washington, D. C.

DEAR SIR: I hereby signify my desire to become a member of the American Forestry Association. Two dollars (\$2.00) for annual dues enclosed herewith.

Very truly yours,

Name _____

P. O. Address _____

For Sale by FORESTRY AND IRRIGATION, 510 Twelfth Street, N. W., Washington, D. C.

IMPORTANT BOOKS ON FORESTRY

PRINCIPLES AND PRACTICE OF FORESTRY

Economics of Forestry, The. By B. E. FERNOW. This volume treats of forests and forestry from the standpoint of political economy, and is designed to furnish a trustworthy basis for formulating public policy. Price, \$1.50

First Book of Forestry, A. By FILIBERT ROTH. An outline of the general principles of forestry, written in simple, non-technical language, designed particularly for the beginner. Price, \$1.25

Practical Forestry, for Beginners in Forestry, Agricultural Students and Woodland Owners. By JOHN GIFFORD. A good general description of the principles of forestry with enough technical information to prepare the beginner for more intricate problems. Price, \$1.25

Forest Planting. By H. NICHOLAS JARCHOW. An illustrated treatise on methods and means of restoring denuded woodland, with full instructions. Price, \$1.50

Forestry. (Schwappach.) An English translation of "Forstwissenschaft." Price, 50c.

Hedges, Windbreaks, Shelters and Live Fences. By E. P. POWELL. A treatise on the planting, growth and management of hedges with information concerning windbreaks and shelters. Price, 50c.

North American Forests and Forestry. By ERNEST BRUNCKEN. This volume, expository in its character, is written in a style intended for the general reader, to whom it should convey a good idea of our forests and tenets of forestry. Price, \$2.00

Practical Forestry. By ANDREW S. FULLER. A treatise on the propagation, planting and cultivation, with descriptions and the botanical and popular names of all the indigenous trees of the United States, and notes on a large number of the most valuable exotic species. Price, \$1.50

Principles of American Forestry. By SAMUEL B. GREEN. Prepared especially for students in elementary forestry and for the general reader who wishes to secure a general idea of forestry in North America. Price, \$1.50

Profession of Forestry, The. By GIFFORD PINCHOT. A pamphlet containing an address on that subject by Mr. Gifford Pinchot; also an address by Mr. Overton W. Price on "Study in Europe for American Forest Students," and a list of reference publications for students. Price, 25c.

Tree Planting on Streets and Highways. By WM. F. FOX. A comprehensive treatise on tree planting pleasingly presented and copiously illustrated in half-tones and color plates. Price, \$1.50

FOREIGN IMPORTATIONS

English Estate Forestry. By A. C. FORBES. An authoritative volume on English forest methods from the pen of a well known forester, that should prove of considerable interest to American readers. Price, \$3.60

Forstwissenschaft. (Schwappach.) Price, 10c.

Manual of Forestry. (Schlich.) Five volumes, complete, or separately as follows (price, complete, \$17.20):

Vol. I. "Utility of Trees and Fundamental Principles of Silviculture." Price, \$2.50

Vol. II. "Formation and Tending of Woods." Price, \$3.20

Vol. III. "Forest Management." Price, \$3.20

Vol. IV. "Forest Protection." Price, \$3.60

Vol. V. "Forest Utilization." Price, \$1.80

This is perhaps the most authoritative work that has been issued on the technical side of forestry, translated from the German.

DENDROLOGY, BOTANY, AND IDENTIFICATION OF SPECIES

Manual of the Trees of North America (exclusive of Mexico). By CHARLES SPRAGUE SARGENT. A volume that presents in convenient form and with excellent illustrations, authoritative information concerning the trees of North America. It is written in a manner that enables the reader to readily find what family or species any particular tree belongs. Price, \$6.00.

American Woods. By ROMEYN B. HOUGH. A new departure in the publication of an authoritative work illustrated with actual wood sections of the various species described. Three are given of each, viz., radial, transverse, and tangential. Issued in ten parts, per part Price, \$5.00

Among Green Trees. By JULIA ELLEN ROGERS. This book supplies the demand for a nature book on trees which is more than mere systematic studies. The book treats of general principles, etc., and gives tree history and life accurately. Price, \$3.00

Familiar Trees and Their Leaves. By F. SCHUYLER MATTHEWS. This little volume contains a large amount of interesting information concerning the better-known trees of the eastern United States. The botanical name and habitat of each tree is given, along with a record of the precise character and color of its foliage. Price, \$1.75

Flora of the Northern United States and Canada. By BRITTON and BROWNE. A complete and accurate key to the flora of the region covered. 3 vols. Price, \$12.00

Flora of the Southern States. (Chapman.) This is an excellent key to the flora of the south, complete and accurate in its scope. Price, \$4.00

Getting Acquainted with the Trees. By J. HORACE MCFARLAND. A handsome volume, copiously illustrated, and with facts accurately presented in an entertaining way. Price, \$1.75

Handbook of Plants. (Henderson.) Price, \$3.00

How Plants Grow. By ASA GRAY. An understanding of the way in which a tree grows is of prime importance to the forester, and the matter here presented is accurate and authoritative. Price, 80c.

How to Tell The Trees. By J. G. LEMMON. A pocket dictionary of the trees designed particularly for the identification of western species, and written in an entertaining manner. Price, 50c.

Manual of Botany. By ASA GRAY. A key to the flora of the northeastern states, and the most authoritative publication of its nature. Price, \$1.62; field edition, \$2.00

Our Native Trees. By HARRIET L. KEELER. A popular key to the trees of the northeastern United States, presented in manner giving easy access to the text. The book is accurate, and as far as possible is written in a style which would make it interesting to the beginner. Price, \$2.00

Our Northern Shrubs. By HARRIET L. KEELER. This volume is planned on the same lines as the foregoing, and describes the shrubs which are native to the region extending from the Atlantic Ocean to the Mississippi River and from Canada to the northern boundaries of our Southern states. The arrangement is by families and each member is given a popular and scientific description. Price, \$2.00

Principal Species of Wood; Their Characteristic Properties. By CHARLES HENRY SNOW. No attempt is made to give exhaustive descriptions of species, but the author presents a mass of information designed for the use and instruction of woodworkers, etc., in a popular style. A host of concise information is brought under each head, and the work is a valuable one. Price, \$3.50.

These books sent prepaid upon receipt of price indicated, by FORESTRY AND IRRIGATION, 510 Twelfth Street, N. W., Washington, D. C.

*Important Books on Forestry and Irrigation for sale by FORESTRY AND IRRIGATION
510 Twelfth Street, N. W., Washington, D. C.*

Studies of Trees in Winter. By ANNE OAKES HUNTINGTON. A description of the deciduous trees of northeastern America with keys for their identification in winter, written in a bright, entertaining style, and containing a mass of valuable information. *Price, \$2.25*

Trees of New England. By L. L. DAME and HENRY BROOKS. This book is a small volume which can be easily put in the pocket and carried in the woods, and at the same time is the best guide to the identification of our New England trees of any of the smaller books yet published. *Price, \$1.50*

Trees of Northeastern America. (NEW-HALL.) A good general check list of the more important trees of the northeastern United States. *Price, \$1.75*

Trees and Shrubs. By C. S. SARGENT. The most thorough and authoritative publication yet issued, and a standard work. The matter is issued in parts, of which there are three already published. *Price, per part, \$5.00*

Trees, Shrubs and Vines of the Northeastern United States. By H. E. PARKHURST. In this book the author describes the trees, shrubs, and vines of the northeastern United States in a popular way, the book being designed especially for persons who have never studied botany. To these it will appeal as a valuable guide to a familiarity with the salient characteristics of trees, shrubs and vines. *Price, \$1.50*

West American Cone Bearers. By J. G. LEMMON. Written in a simple style, this book, with its conveniently small size, is a ready guide to the conifers of the Western coast. *Price, \$1.00*

DESCRIPTION OF PARTICULAR SPECIES AND LOCALITIES

Adirondack Spruce, The. By GIFFORD PINCHOT. A study of the habits of an important lumber tree; its rate of wood accretion per tree per acre, with conclusions drawn from this study as to

the financial possibility of practical forestry in dealing with the species. *Price, \$1.00*

Mountains of California, The. By JOHN MUIR. No other person is so well fitted to write of the mountains of California as John Muir, and the volume presented here describes not only the mountains themselves but the trees that clothe them and the wild life which they harbor. *Price, \$1.75*

White Pine, The. By GIFFORD PINCHOT. The study of an important timber tree; its habits, rate of wood accretion per tree per acre, with conclusions drawn as to the financial possibility of practical forestry in dealing with the species. *Price, \$1.00*

Our National Parks. By JOHN MUIR. If you want to learn about the glaciers, mountain peaks, canyons and great waterfalls of the West; of the habits of animals from the squirrel to the moose; plant life from the big trees to the wild flowers — in fact be brought face with nature's works, this is the book. *Price, \$1.75*

IMPORTATIONS

Beautiful Rare Trees and Plants. By the EARL OF ANNESLEY. A description of some of the rarer English trees, shrubs and vines, illustrated copiously. *Price, \$12.00*

Forests of Upper India and Their Inhabitants. By THOMAS W. WEBBER. This volume is an account of the author's life in India during the period shortly after 1857. It contains a vivid description of the country, its people, customs, etc., with some description of its forests and timber wealth. *Price, \$5.00*

Important Philippine Woods. By Captain GEORGE F. AHERN. This is the only authoritative compilation of the more important woods of the Philippines, with copious illustrations, part of which are in color. Captain Ahern is the head of the Forestry Bureau of the Philippines. *Price, \$3.00*

BOOKS ON IRRIGATION AND DRAINAGE

Irrigation in the United States. By F. H. NEWELL. The most authoritative and complete work on the subject which has yet been published, by the head of the Government's irrigation work. *Price, \$2.00*

Irrigation for Farm, Garden and Orchard. By HENRY STEWART. This work is offered to those American farmers and other cultivators of the soil who, from painful experience, can readily appreciate the losses which result from the scarcity of water at critical periods. *Price, \$1.00*

Irrigation and Drainage. By F. H. KING. While most of the existing books on these subjects have been written from engineering or legal standpoints, this one presents in a broad yet specific way the fundamental principles which underlie the methods of culture by irrigation and drainage. *Price, \$1.50*

Farm Drainage. By JUDGE FRENCH. The principles, process, and effects of draining land with stones, wood, ditch-plows, open ditches, and especially with tiles; including tables of rainfall, evaporation, filtration, excavation, capacity of pipes, cost and number to the acre. *Price, \$1.00*

Land Draining. By MANLY MILES. A handbook for farmers on the principles and practise of draining, giving the results of his extended experience in laying tile drains. *Price, \$1.00*

Practical Farm Drainage — Why, When, and How to Tile Drain. By C. G. ELLIOTT. The book is a clear exposition of the methods of tile draining, with a discussion of the effects, and much valuable related matter. *Price, \$1.00*

Land of Little Rain, The. By MRS. MARY AUSTIN. A nature book of the highest type. The volume is made up of a series of sketches of the human, animal, and plant life found in the region of the Mohave desert, Death Valley, and the Sierras, much of which the average person is likely to consider almost devoid of living things. *Price, \$2.00*

IRRIGATION ENGINEERING AND CONSTRUCTIVE WORK

Design and Construction of Dams. By EDWARD WEGMANN. This volume includes an authoritative discussion of the constructive work involved and the principal forms of construction. Masonry, rock-fill and timber dams are discussed extensively. *Price, \$3.00*

Improvement of Rivers. By B. F. THOMAS and D. A. WATT. This volume is a treatise on the methods employed for improving streams for open navigation and for navigation by means of locks and dams. *Price, \$6.50*

Irrigation Engineering. By HERBERT M. WILSON. This is the fourth edition of Mr. Wilson's popular work, and the revision and enlargement which it has undergone, places it at the forefront of text books on the subject for American students. *Price, \$4.00*

Engineering for Land Drainage. By C. G. ELLIOTT. A manual for laying out and constructing drains for the improvement of agricultural lands. *Price, \$1.50*

Reservoirs for Irrigation, Water-power, and Domestic Water-supply. By JAMES DIX SCHUYLER. An account of various types of dams and the methods and plans of their construction, together with a discussion of the available water-supply for irrigation in various sections of arid America, distribution, application, and use of water; the rainfall, runoff, and evaporation from reservoirs, and effect of silt, etc. *Price, \$5.00*

Water Supply Engineering. By A. PRESCOTT FOLWELL. A treatise on the designing, construction and maintenance of water-supply systems, both city and irrigation. *Price, \$4.00*

Water Power. By JOSEPH P. FRIZZELL. An outline of the development and application of the energy of flowing water. *Price, \$5.00*

*These books sent prepaid upon receipt of price indicated, by FORESTRY AND IRRIGATION
510 Twelfth Street, N. W., Washington, D. C.*

The Proceedings

OF THE

American Forest Congress

recently held at Washington, D. C.,
have been published in book form

This volume contains the full list of notable addresses and papers delivered at the several sessions of the Congress, a list of the delegates who were present, and the text of the resolutions adopted.

Altogether it forms the most comprehensive and authoritative publication on the subject of forestry that has yet been issued in the United States.

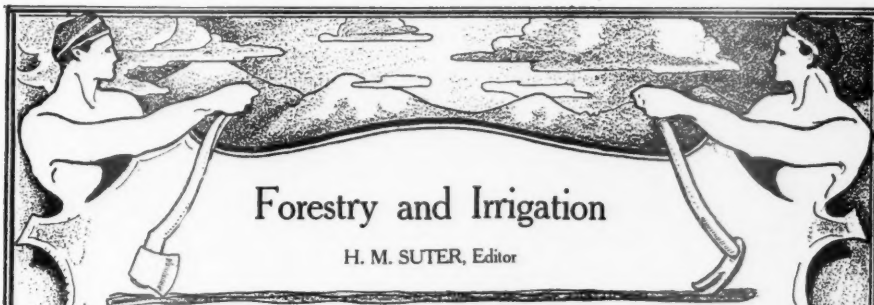
The price of the book is \$1.25 POSTPAID.

Orders should be accompanied by remittance, and may be sent to

H. M. SUTER,

Secretary American Forestry Association,

510 Twelfth St., N. W., Washington, D. C.



CONTENTS FOR JUNE, 1905

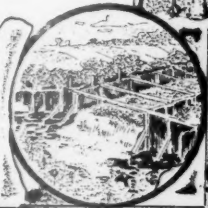
THE RECENT FLOOD IN SALT RIVER VALLEY, ARIZONA - - - - -		Frontispiece
NEWS AND NOTES (<i>Illustrated</i>):		
Proceedings Issued - - -	247	Planting Plan for Gunnison Reserve - - -
Game Reserve - - -	247	Irrigation Contracts Awarded
Forestry on a Private Reserve - - -	247	Transplanting "Big Tree" Seedlings - - -
Oklahoma Land Withdrawals - - -	247	Telephone for Dismal River Reserve - - -
Co-operative Forest Work	247	Timber Cutting in Forest Reserves - - -
Grazing Inspection - - -	248	To Test Materials - - -
Reclamation Appointments and Transfers - - -	248	Plan for Planting Coal Lands
Tree Planting by Bureau -	250	To Plant Watersheds - - -
New Forest Reserves - - -	250	Forest Students Chosen -
		Planting in Black Hills -
RECENT CONDITIONS IN SALT RIVER VALLEY, ARIZONA (<i>Illustrated</i>) - - - - -		Gerard H. Matthes 255
EUROPEAN STUDY FOR FORESTERS -		T. S. Woolsey, Jr. 260
THE EFFECT OF FOREST COVER UPON STREAM FLOW PART I - - - - -		W. B. Greeley 263
A SUCCESSFUL ROOT PRUNING DEVICE (<i>Illustrated</i>) - - -		268
THE UPBUILDING OF NEVADA (<i>Illustrated</i>) - - -		270
THE WATER LEVELS OF THE GREAT LAKES - - -		274
THE RECLAMATION SERVICE (<i>Illustrated</i>) - - -		276
THE NEW MONTANA - - -		285
A SUGGESTION REGARDING THE NATIONAL FOREST RESERVES (<i>letter from G. Frederick Schwarz</i>) - - -		287
WATER PROBLEMS OF SANTA BARBARA - - -		290
STREAM MEASUREMENTS IN THE UNITED STATES - - -		291

FORESTRY AND IRRIGATION is the official organ of the American Forestry Association. Subscription price \$1.00 a year; single copies 10 cents. Copyright, 1904, by H. M. Suter Publishing Co. Entered at the Post Office at Washington, D. C. as second-class mail matter.

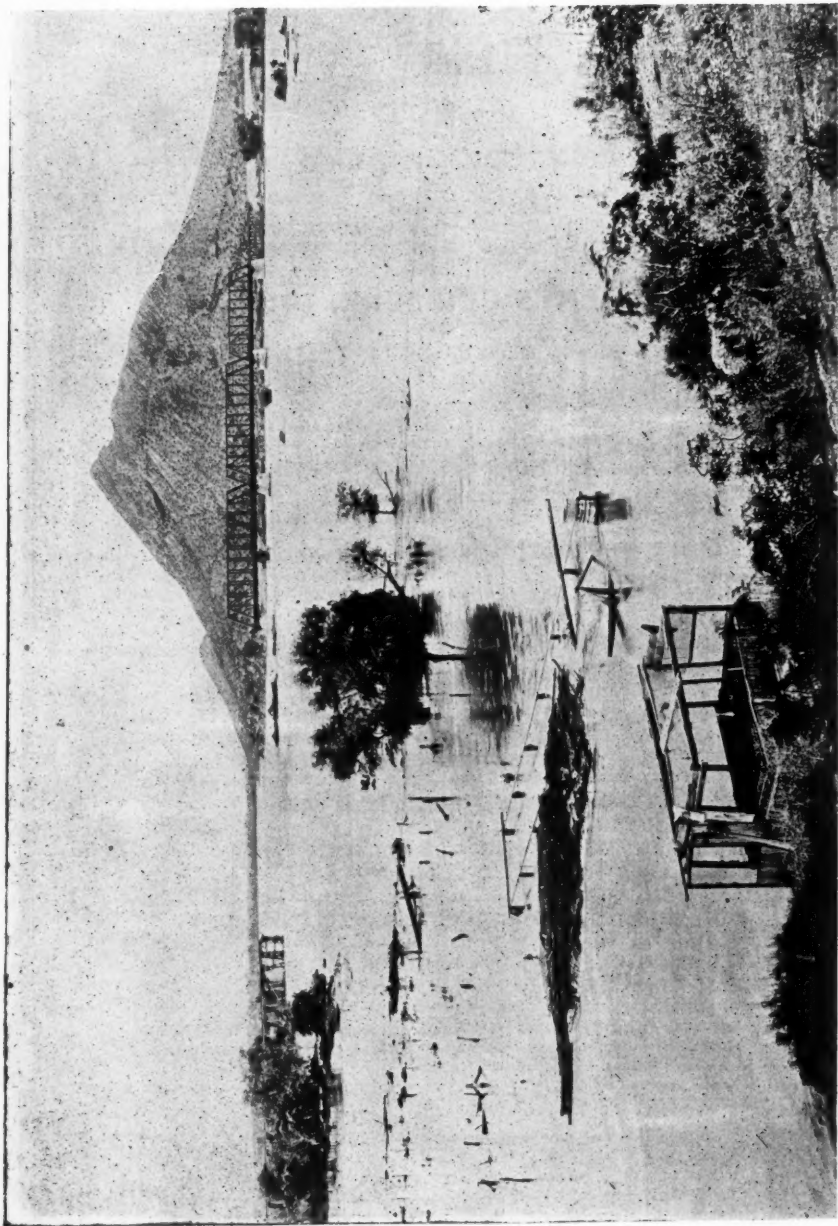


Published Monthly at

WASHINGTON, D. C.



JOHN E. SHERIDAN



The Recent Flood in Salt River Valley, Arizona. View looking toward Tempe Butte from the North end of the Southern Pacific railroad bridge, showing flooded forms on the North side of Salt River; also Santa Fe's wrecked bridge caused by flood on the night of April 12th, 1903.

Forestry and Irrigation.

VOL. XI.

JUNE, 1905.

No. 6

NEWS AND NOTES

Proceedings Issued

The proceedings of the American Forest Congress have just been issued in book form. The volume contains about 480 pages, and includes every paper read at the various sessions of the Congress, and a large number of the more important impromptu addresses, and is substantially and neatly bound in green cloth. The American Forest Congress, held at Washington, D. C., January 2 to 5, was, according to President Roosevelt, "A meeting which is without parallel in the history of forestry," and this volume, with its complete record of the proceedings, is the most authoritative publication that has been issued on the subject of American forestry. The H. M. Suter Publishing Company, P. O. Box 356, Washington, D. C., are issuing the book. It is sold for \$1.25 a copy post paid.

Game Reserve

Putting into effect a law passed by the last session of Congress, the President has proclaimed the whole Wichita Forest Reserve a game preserve. The reserve is in Oklahoma Territory, and contains 57,120 acres. Declaring it a game preserve takes away none of its functions as a reserve, it merely suspends all territorial game laws. In the future, under regulations prescribed by the Secretary of Agriculture, game, especially quail and wild turkeys, will be protected and encouraged to propagate in the preserve.

Forestry on a Private Reserve

The Bureau of Forestry has been called upon to devise a plan by which the owner of a forest on a summer resort island may cut the timber with-

out impairing the scenic effect of the forest. It is a hardwood forest of about 7,000 acres, and covers half of Manitou Island, Lake Michigan. About half the forest is virgin timber. The owner desires a steady product, but to have the cutting done in such a way that the forest will remain an attraction of the island. Mr. S. J. Record, of the Bureau, is in charge of the work, and will be assisted by four field men.

Oklahoma Land With- drawals

The Commissioner of the General Land Office has temporarily withdrawn from any form of disposition whatever, the following lands in the Territory of Oklahoma, in connection with the Navajo reservoir site on Red River:

Indian meridian T. 2 N., R. 18 W., Sections 4 and 5.

T. 5 N., R. 18 W., Sections 6, 7, 17, 18, 19, 20, 28, 29, 30, 31, 32, 33.

T. 3 N., R. 19 W., Sections 1, 2, 3, 9, 10, 11, 12, 13, 14, 15, 16, 22, 23, 14, 25, 16, 36.

T. 4 N., R. 18 W., Sections 5, 6, 7, 8, 17, 18, 19, 30, 31.

T. 4 N., R. 19 W., Sections 1, 2, 3, 11, 12, 13, 14, 22, 23, 24, 25, 26, 27, 34, 35, 36.

T. 5 N., R. 19 W., Sections 31, 35, 36.

Co-operative Forest Work

The Bureau of Forestry has begun another co-operative piece of work with the Northern Pacific Railroad. It is an investigation of the problem of a future supply of railroad ties for the section of the line east of Montana. The present eastern supply will last, at the outside, not longer than fifteen years, and the railroad is anx-

ious to know whether it will be cheaper to haul from its holdings in the Rocky Mountains the million ties needed annually for the eastern line, or to grow them somewhere in Minnesota or Wisconsin. These states are preferred as they are near the railroad and cheap land can be secured there. The investigation by the Bureau will establish the possibility and the cost of producing ties in these states. If ties are brought from the Rockies they would probably be of lodgepole pine; if grown in Minnesota or Wisconsin some of the inferior hardwoods or possibly pine would be preferred. The result of this study will be of interest to all railroads, since the tie supply question is one of increasingly great importance. Mr. H. H. Chapman, the bureau agent, who will be in charge of the work, has started his investigations, which will cover several months.

Another application has been received by the Bureau of Forestry for a preliminary examination of a watershed on the chaparral-covered slopes of the mountains of Southern California, this being the third of the kind received within the last few weeks. These requests are largely the result of the experimental work in reforestation which has been carried on by the Bureau of Forestry in the San Gabriel Mountains back of Pasadena. The growing value of water and the realization that the chaparral cover does not satisfactorily retain the precipitation, has led many irrigation companies to seriously consider the subject. This last application was from an irrigation company in Santa Ana, Orange County, and their desire is to reforest, if possible, the drainage basin of Santiago Creek in the Santa Ana Mountains. At present the run-off is very rapid during the heavy rains, and the flow of the stream deficient in summer. This follows as the result of repeated fires in chaparral and the denuded condition of many slopes.

Agents of the Bureau of Forestry

have commenced to make maps of the southern part of New Hampshire which will show the timber land, the agricultural land, and the barren areas suitable for tree planting. This work is done in cooperation with New Hampshire, and some 4,000,000 acres will be mapped this summer. Forest work in the state will be done chiefly with the view of advising farmers and owners of second-growth forest as to the best management for the production of pulp wood, box boards, fire wood, etc. Another object is to complete a forest policy for the state, covering legislation upon fire and forest taxation, also a system to protect timberland and to encourage conservative forest management. Mr. C. A. Lyford, agent of the Bureau of Forestry, detailed in charge of this work, is now in New Hampshire in consultation with its State Forest Commission. He will be assisted in his work by some ten or more bureau field men.

Grazing Inspection

Mr. A. F. Potter, forest inspector, left yesterday for the west to make special investigations relating to grazing in the forest reserves. He will cover Utah, Wyoming and Montana in the early part of the season, and California in the fall.

Reclamation Appointments and Transfers

Among the recent appointments, assignments and transfers in the U. S. Reclamation Service the following are noted:

Clayton W. Bowles, of Orono, Maine, has received an appointment as engineering aid and directed to report to F. E. Weymouth, Glendive, Montana. Mr. Bowles took a course in civil engineering in the 1905 class, University of Maine, and has had experience in connection with the Fort Buford project, North Dakota, during 1904.

Harold N. Cross, of Exeter, N. H., has been appointed assistant engineer, and will report for duty to F. E. Weymouth, Glendive, Mont. He graduated from the Thayer School of Civil

Engineering and had one year post-graduate work. Mr. Cross worked during the summer of 1903 in New York city; he also had four years in sanitary engineering in the Massachusetts Institute of Technology.

Walter B. Freeman has been appointed hydrographic aid and assigned to duty under C. C. Babb, Browning, Montana.

Lewis E. Foster, appointed engineering aid, will report at Glendive, Montana to assist in soil classification work. An experienced orchardist, Mr. Foster is well qualified for work in bureau of soils. He has had considerable experience in surveying.

Frank H. Brundage, assistant engineer in the Reclamation Service, has been directed to report to J. Ahern, Cody, Wyoming.

Ralph C. Soper, engineering aid in the Reclamation Service, will report for duty to J. Ahern, Cody, Wyoming.

Albert E. Wood, of Cleveland, O., has received an appointment as engineering aid and directed to report to J. E. Field, Fort Laramie, Wyoming. Mr. Wood graduated from Fayette Normal School with the degree of B. S., and is now a senior in civil engineering, Case School of Applied Sciences.

Carl R. Weitze, of Clinton, Mass., and a graduate of Scientific School of Harvard University with degree of C. E., has been appointed engineering aid and directed to report to C. W. Smith on Roosevelt dam, Arizona. Mr. Weitze has had considerable experience in engineering for State of Massachusetts, and also acted as instructor in plane, railroad and geodetic surveying at Swain Lake, N. H.

Wm. E. Martin, of Texas, has been appointed hydrographic aid and will assist W. B. Clapp in hydrographic work at Los Angeles, California. Mr. Martin graduated from Sam Houston State Normal School, Huntsville, Texas, and from the University of Texas, at Austin. He has worked in railroad location and stream gaging,

and made experiments regarding the evaporation of water.

Wm. A. Lamb, Denver, Colo., graduate of Colorado State Agricultural College, has been appointed engineering aid and will act as field assistant to M. C. Hinderlider. He has had considerable experience in hydrographic work and has been engaged during the past year by the U. S. Geological Survey.

Leroy F. Harza, of Madison, Wisconsin, engineering aid, has been assigned to duty under C. S. Slichter, Madison, Wis. Mr. Harza attended the South Dakota Agricultural College and is now taking a scientific course in the University of Wisconsin. He was county surveyor of Moody County, S. D., for two years and has been engaged in surveying for sewer location.

Walter B. Harrington, of Wadsworth, Nevada, has been appointed engineering aid and will be engaged under supervising engineer L. H. Taylor, with whom he is now associated as "field assistant." Mr. Harrington graduated from the University of Nevada as mining engineer and has been employed on the Truckee high line canal under the direction of Prof. Chandler.

Frederick L. Humphrey, of New York city, has been appointed engineering aid and will be engaged for some time in the Washington office of the Reclamation Service. Mr. Humphrey has had extensive experience in civil engineering in connection with his college course in the Columbia University, New York city.

Edward L. Edes, of Reading, Mass., has received an appointment as engineering aid and requested to report to G. L. Swendsen, Salt Lake City, Utah. Mr. Edes, who is taking a course in the Massachusetts Institute of Technology, has had practical experience in connection with his college course in civil engineering.

Frederick A. Biggi, of New York city, has received an appointment as engineering aid in the Reclamation Service, and will be engaged at pres-

ent in the Washington office. Mr. Biggi graduated from the Massachusetts Institute of Technology with the degree of C. E., and has been engaged in various capacities of surveying, drafting, etc., by the city of Boston.

Adolph H. Rossong, of Madison, Wis., has been appointed engineering aid and ordered to report for duty to J. E. Field, at Fort Laramie, Wyoming. Mr. Rossong took a general scientific course in the University of Wisconsin and graduated from the college of Mechanics and Engineering with the degree of C. E.

Verney W. Russell, of New Hampshire, has received an appointment as engineering aid and directed to report for duty at Cody, Wyoming. Mr. Russell graduated from Dartmouth College and had considerable experience in connection with his college work.

Tree Planting by the Bureau

The planting operations the Bureau of Forestry is carrying on in cooperation with the Delaware and Hudson Railway Company along their Chateaugay Division in the Adirondacks, is progressing rapidly. G. B. Lull, of the Bureau of Forestry, is in charge of the work. The nursery which is being established at Wolf Pond is nearly completed, and will have a capacity of 300,000 plants. In addition seeds will be planted on denuded areas by the seedspot method. The object of the work is to reforest the 28,000 acres of land along the railroad, which have been denuded by lumbering and repeated fires. With the growing scarcity and increased cost of cross ties, the importance of this work can hardly be overestimated. The most promising species used is the European larch, as it grows rapidly, is easily propagated, and is of high value for posts, telephone poles and railroad ties. The other species which are being planted are Scotch pine, white pine, and Norway spruce.

The season's forest planting operations have been begun in the Pikes Peak Forest Reserve. F. W. Besley,

of the Bureau of Forestry, has gone from the Dismal River Reserve to Colorado to begin this work. He will direct the planting of 50,000 trees which were grown in the Dismal River Reserve Nursery, and will plant additional seedbeds and care for the three forest nurseries established near Pikes Peak last year. This work follows a carefully prepared preliminary reforestation plan made in 1903 and 1904.

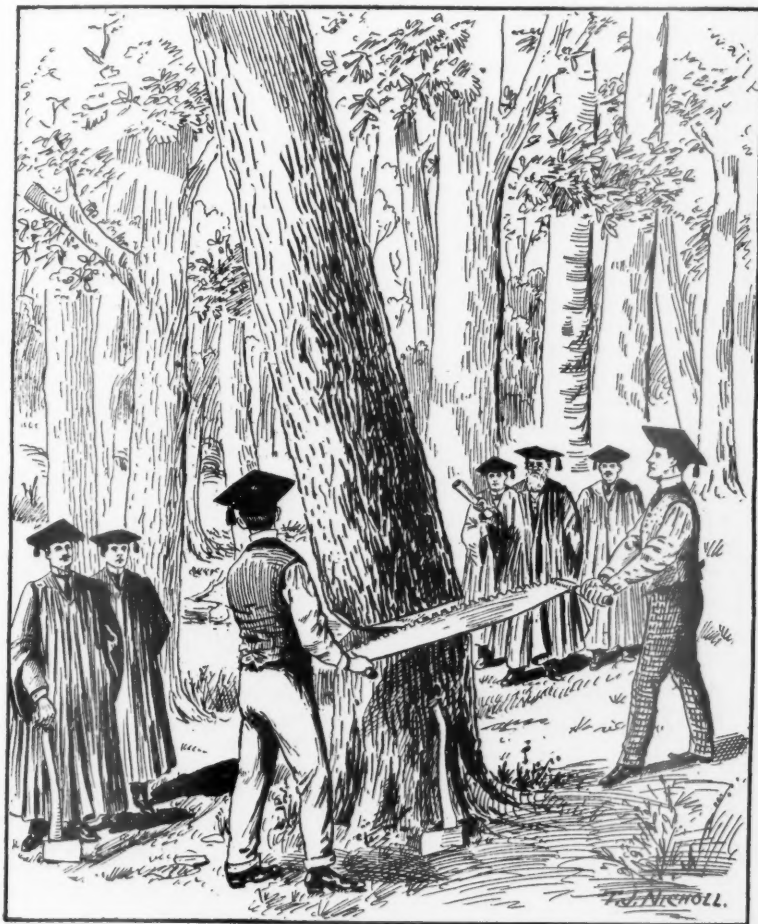
New Forest Reserves

The President has proclaimed another reserve in Idaho. It is called the Sawtooth Forest Reserve, is located in the southern-central part of the state, and contains something over 1,900,000 acres. It is well timbered, practically all unsurveyed, and has no settlements except a few small mining camps. The region is very rough, and has few roads and trails. The land has no agricultural value, but is important for its forests, stock range and mineral resources. The reserve is created to protect the timber, but more particularly to protect the watershed of the Boise River, and thus to make possible the success of the Boise Valley irrigation project, upon which depends the agricultural future of the region.

The President has proclaimed two more forest reserves, the San Juan in southeastern Colorado, and the Payette in central Idaho. Each reserve is about the same size, something under 1,500,000 acres. The chief purpose in creating each reserve is to better protect watersheds upon which depend vast areas that can be reclaimed to agriculture by irrigation. The land irrigable by streams from the San Juan reserve extends beyond the border of Colorado into New Mexico. The timber in neither reserve is at present very valuable, but it will improve with time, especially if fire is kept out. In the San Juan area there has been some overgrazing, to the injury of both the forest and the range. In the Payette reserve the land is very rough and the soil poor, while half

THE NEW SCHOOL OF LUMBERING

[At the annual meeting of the National Lumber Manufacturers' Association, held at Chicago in May, it was resolved to lend its aid to the endowment of a chair of lumbering at the Yale Forest School.]



PRACTICAL WOODS WORK

Professor—Now, young gentlemen, when the angle of declination of the bole of this perennial woody plant reaches—never mind the scientific exposition—scoot!

—*The Hardwood Record.*

of the area is inaccessible to grazing. Under Forest Service regulations the timber and the range will be improved, and agricultural conditions will be vastly benefitted.

Planting Plan S. B. Detwiler has gone for Gunnison to Colorado to carry on, Reserve in the newly created Gunnison Forest Reserve, forest replacement studies for the Bureau of Forestry. The object in view is the preparation of a preliminary reforestation plan for this region. Similar plans have been made for other reserves where planting work is now in progress, and are necessary in order to determine areas that are suitable, or unsuitable, for planting, and the watersheds which are in the most urgent need of attention. The work in the Gunnison Reserve is particularly important because of the large irrigation projects which are under way. Since the condition of the forest cover on the slopes above reservoir sites determines to a large extent the quality and regularity of the water supply, any action which leads to a reforestation of denuded slopes will add just so much to the irrigation possibilities of the region. Mr. Detwiler's report, when completed, will show the areas which should be planted at once, those which are not in such urgent need, the tree species to be used, where forest nurseries should be located, and will contain an approximate estimate of the cost of all contemplated operations.

Irrigation Contracts Awarded The Secretary of the Interior has awarded contracts to the lowest bidders for construction of the Interstate Canal, North Platte project, Nebraska, as follows:

Robinson & Maney, St. Louis. Divisions 1, 2, 6, 7, 9 and 10; Griffith & McDermott, Chicago, Division 3; Deadwood Construction Co., Division 4; Orman & Crook, Pueblo, Colo., Division 5; James O'Connor, Morgantown, Ind., Division 6.

The lowest bids on the several divisions are as follows:

1. Robinson & Maney, \$40,599.
2. Robinson & Maney, \$42,332.
3. Griffith & McDermott, \$78,135.
4. Deadwood Const. Co., \$32,695.
5. Orman & Crook, \$76,647.
6. Robinson & Maney, \$35,335.
7. Robinson & Maney, \$35,135.
8. James O'Connor, \$37,560.
9. Robinson & Maney, \$33,266.80.
10. Robinson & Maney, \$29,700.

Transplanting "Big Tree" Seedlings Contrary to prevalent belief, the famous "Big Trees" of California do reproduce themselves under certain favorable conditions. The trees seed freely, but the seed rarely germinate except when they fall where the ground has recently been burned over. Once started the young growth only needs a moderate amount of light and protection from fire and stock grazing. With some care this race of forest monarchs need not become extinct, but may be greatly multiplied. The number of mature trees is not great, and healthy young growth is rare, but in some situations there are plenty of seedlings. In order to establish these trees more widely, it is proposed to move some of the seedlings to localities where they will be apt to grow.

The first extensive transplanting of the "Big Trees" has recently been finished by Ranger Lewis L. Davis in the General Grant National Park, California. In the spring of 1904 it was noticed that a large number of tiny sequoias sprang up where debris had been burned. Advantage was taken of the opportunity to place the seedlings which appeared where they would have opportunity to develop. Ranger Davis has thus far transplanted about 1,400, and those set last year have nearly all grown.

Telephone for Dismal River Reserve The Forest Service men in charge of the planting and nursery work on the Dismal River Forest Reserve, Nebraska, have taken advantage of the numerous barb-wire fences of the region to install a complete telephone system by stringing a few connecting wires, and mending breaks and put-

ting in insulators where needed. They have connected their headquarters with ranches throughout the surrounding country, and with small towns in the neighborhood. This not only gives them social advantages, but enables them to order supplies or to receive prompt information in case forest fires are discovered.

Timber Cutting in Forest Reserves Timber sale transactions and the actual cutting in progress on the government forest reserves now involve a fraction under 91,000,000 board feet of lumber, 50,913 cords of wood, 513,000 railroad ties, and 36,885 posts, poles, and stays. This is outside the free use of wood for local domestic and farm purposes, which aggregates a large amount. It is conclusive proof that the mature timber on the reserves is for use, and the Forest Service will continue to dispose of it as rapidly as possible in the interest of the public, and in order to improve the condition of the forests.

To Test Materials An interesting meeting, and one which will have far-reaching influence in solving many vital economic questions, has just been held in Washington. The meeting was a conference between prominent engineers and officials of the U. S. Geological Survey and the Bureau of Forestry on the problems connected with the testing of structural materials, such as stone, cement and timber.

The extensive program which has been outlined as a result of this meeting is of special significance to the Reclamation Service, as no feature in connection with the construction of the government's irrigation works is of more vital importance than the character, durability and strength of the materials which enter into their formation.

The wide interest which is felt in these investigations was evident in the presence of representative members of many of the leading corporations of the country, who expressed their desire to cooperate in the work. The fol-

lowing gentlemen attended the meeting:

Dr. C. B. Dudley, chairman of the conference, president American Society for Testing Materials, chief chemist Pennsylvania Railroad; C. C. Schneider, president American Society of Civil Engineers; R. L. Humphrey, president American Society of Cement Users and cement expert U. S. Geological Survey; R. W. Lesley, vice-president American Society for Testing Materials, editor *Cement Age*; G. S. Webster, chief engineer City of Philadelphia; E. A. Foose, representing Mr. J. E. Muhlfeld, general superintendent of Motive Power, Baltimore and Ohio Railroad; E. F. Kenney, representing Mr. Joseph T. Richards, chief engineer Pennsylvania Railroad, Philadelphia; Mr. Burleigh, representing Mr. James K. Taylor, supervising architect of the Treasury; A. A. Robinson, representing Mr. James Dunn, chief engineer Santa Fé Railway, Chicago; D. W. Lum, chief engineer Southern Railway; W. C. Cushing, chief engineer Pennsylvania lines west of Pittsburg; J. E. Deems, general superintendent of motive power, New York Central and Hudson River Railway; C. H. Buckingham, supervisor of fuels, New York Central and Hudson River Railway; J. E. Greiner, representing Mr. D. D. Caruthers, chief engineer, Baltimore and Ohio Railroad; F. H. Newell, chief engineer Reclamation Service; Gifford Pinchot, Forester, U. S. Department of Agriculture; Prof. J. A. Holmes, in charge of testing work of the U. S. Geological Survey; W. L. Hall, in charge of testing work for Bureau of Forestry.

Arrangements have been made for a continuous advisory board to work with the Bureau of Forestry and the Geological Survey in the conduct of their official tests. This cooperation will mean that in advance of any tests these bureaus will have the benefit of the suggestions and advice of the foremost engineers of the country in special lines of work. It is the first time in the history of our government that

such coöperation has been effected, and it is believed that the relations thus established will result in more expeditious and satisfactory work, and will prove of great economic advantage to both public and private interests.

The initial work, that of analyzing and testing the relative steam producing powers of coals and lignites of the United States, which was inaugurated during the summer of 1904, at St. Louis, will also be continued. The various portions of the plant were contributed by different manufacturing companies, and the railroads entering St. Louis or having coal resources along their lines coöperated most heartily with the committee in charge of the work. The results of this work are very interesting and valuable.

Plan for Planting Coal Lands A planting plan for a portion of the lands of the Keystone Coal and Coke Company, of Greensburg, Pa., has just been finished by the Bureau of Forestry. This company owns several thousand acres overlying coal beds. It is proposed by the planting of rapid-growing trees to make these lands more productive than under the old plan of renting on shares for agricultural purposes. A small nursery was established and several thousand young chestnut and maple trees were set out this spring. A detailed planting plan was also prepared giving directions for future operations. Black locust is the species which will be mainly used.

To Plant Watersheds A planting plan for certain important watersheds, and recommendations for the treatment of lands in the interior of the San Gabriel Forest Reserve, California, have just been completed by Mr. A. T. Searle, of the Bureau of Forestry. This report considers the possibilities of planting on various types of denuded and chaparral covered land in these mountains, and embodies recommendations as to the species which should be used, methods of planting, and locates the

slopes which are in the most urgent need of attention. These recommendations are based on experience gained in experimental work which has been under way for several years and are intended to give a definite, systematic plan of procedure for future operations. The chaparral growth has been divided into five well defined types which require special treatment. The most hardy species, such as knob-cone, Monterey, and Digger pine will be planted in the more unfavorable situations, while the more valuable but less hardy trees, such as yellow, sugar, and Coulter pine, and spruce and cedar, will be planted on the more favorable sites.

Forest Students Chosen The Bureau of Forestry has completed the selection of forest students for the coming season. The men were chosen from the most promising students of forest schools and will be assigned for the summer to the collection of data, under the direction of trained foresters, in various lines of the Bureau's activities. There will be 29 such students appointed July 1, from a total of about 200 applicants.

Planting in Black Hills Planting operations in the Black Hills Forest Reserve are being pushed rapidly under the direction of L. C. Miller, of the Forest Service. A recent examination has revealed such favorable conditions that it has been decided not to use nursery stock extensively in reforesting the denuded areas. Instead, several hundred pounds of seed will be sown directly on the land where trees are desired. In order to compare the nursery method with that of direct sowing, about 50,000 small trees grown in the Dismal River Reserve nursery, in Nebraska, will be set out. The region in which operations are under way is in the vicinity of Custer Peak, where lumbering and fire have denuded the ground. The season thus far has been unusually rainy, and while it has delayed operations it will ultimately contribute much to the success of the work.

RECENT CONDITIONS IN SALT RIVER VALLEY, ARIZONA

BY

GERARD H. MATTHES

Engineer, United States Reclamation Service

THE unusual meteorological conditions which have prevailed throughout the United States during the early part of the present year have made themselves peculiarly felt in the arid regions of the southwest. Weeks

an unwonted aspect of verdure with their luxuriant growths of grass, weeds and cacti, and in places the once barren desert soil is covered with a vegetation so rank and prolific as to savor of tropical conditions. My-



View showing the remaining portion of the Arizona dam, which was washed away by the Flood of April 13.

of continued rainfall, alternating with cloudiness, have produced a change in the aspect of the desert lands, particularly at the lower levels, which is the more remarkable, following as it does a series of exceedingly dry years. The deserts of Arizona have assumed

riads of wild flowers, among them many a rare species, such as the lily of the desert, covered the plains and foothills during April and May, like a brilliant carpet painting the landscape with the most gorgeous of hues, and causing the traveler gazing upon

this lavish display of western flora to revel in the splendor of the scene and to wonder at the productiveness of the desert soil.

While the copious snows and rains have proven of inestimable value to the stock ranges on the high plateaus and to the agricultural interests in the valleys, incalculable damage has been inflicted by floods to property of all kinds. In the populated districts of Arizona, and in the Salt River Valley more in particular, the excessive precipitation has been the cause of washouts along the railroads, wagon-roads, canals, ditches, telegraph and telephone lines, to an extent unparalleled in the history of the valley. The

be washed out by a subsequent rise of the Gila River, and although no expense was spared by the railroad company in rebuilding the structure, it met with the same misfortune time and again, until on March 31 the bridge has been successively destroyed and rebuilt eight times. The same company on April 13 lost the south approach to its bridge across Salt River. This bridge, at the time the accident occurred, was the only means then available for crossing the Salt River for many hundred miles either up or down the river, and its partial failure for a while made all crossing impracticable. The line of the Phoenix and Eastern Railroad, extending



View of the Capitol, Phoenix, Ariz., February 4, showing how the grounds were flooded by waters from Cave Creek.

city of Phoenix, situated in the center of Salt River Valley, and dependent on branch railroads for connection with the main lines of the Southern Pacific and Santa Fe systems, has been a principal sufferer from the repeated interruptions in traffic and means of communication during the months of January, February, March and April. Early in January the Maricopa, Phoenix and Salt River Valley Railroad lost its pile bridge across the Gila River near Sacaton station during a flood, and up to April 1 but little traffic was had over that line. The bridge was rebuilt only to

from Phoenix to Kelvin, Arizona, lost its bridges across both Salt and Gila Rivers, the former a steel bridge, being partly destroyed March 20 through the shifting of the river bed and undermining of two of its piers. Much depended on the maintenance of the two railroad bridges across Salt River, for during five months that stream was unfordable and the only means of crossing it were afforded by these bridges. The Santa Fe, Prescott and Phoenix Railway met with a number of washouts, but succeeded, in spite of delays, in running trains. The main lines of the Southern Pacific and the

Santa Fe systems, and a number of less important railroads suffered from repeated washouts and interruptions in traffic. Principal among the latter is the Gila Valley, Globe and Northern Railway, which lost its bridges and many miles of track along the banks of the Gila River by the caving and washing away of the banks.

Several times during the period referred to Phoenix was cut off from all communication with the outer world, as a result of these washouts. Aside from the main rivers many of the smaller tributaries did much damage.

tol is located was flooded to a considerable extent, the water covering the capitol grounds to a depth of nearly two feet. With its boggy streets emitting a foul odor and a humid atmosphere which would have done credit to a tropical climate, Phoenix was not a desirable abode during the period under consideration for the consumptives and other invalids, who habitually spend the winter months there in search of health.

The ranchers of Salt River Valley sustained damage in many different ways. One after another the diver-



Street scene near the Capitol, Phoenix, Ariz., February 4, showing flood waters from Cave Creek.

Cave Creek, a small torrential stream entering Salt River Valley northwest of Phoenix, was the cause of repeated inundations of a large section of the Salt River Valley, seriously damaging crops, ditches and highways. In several instances the discharge from this creek was so large in volume that the canals in the valley were unable to drain it off, and overflowing them, the water reached the western portion of the city of Phoenix. At one time that section of Phoenix in which the capi-

sion dams maintained across Salt River by the various irrigation enterprises were washed out, and when the waters finally commenced to subside the owners found themselves confronted with difficult problems regarding the reconstruction of these dams, the majority of which had been of a more or less temporary character. All along the river sweeping changes occurred in the river bed, and in more than one instance the new channel was found to be located a long distance

away from the old canal head. The continued high water, moreover, rendered it impracticable to reconstruct these dams in season to turn irrigation water in the ditches for the spring irrigation, and at many points in the valley irrigators were left without water for a considerable period. Fortunately for them, however, the copious rains which had previously soaked the soil proved to be the salvation of many a crop.

One of the most serious calamities to the people of Salt River Valley oc-

by the Arizona Water Company, made immediate preparations to restore their former headgates and soon were able to supply the ranches situated under them with irrigating water. The Arizona Water Company is also preparing to rebuild its dam.

The protracted floods on Salt River in addition to destroying the works of man, did incalculable damage to lands along the river, through the shifting of the river bed and the caving of the banks. At numerous points along the river ravages of this nature assumed



Bridge of the Phoenix and Eastern Railroad across Salt River, damaged by high waters March 20.

curred on April 13, when a high flood destroyed the timber dam of the Arizona Water Company, commonly known as the Arizona Dam. This structure practically controlled all irrigation water used on the north side of the river, and its loss was a serious blow, more especially to the orchards in the northern part of the valley. The older canals known as the Salt River Valley, Maricopa, and Grand Canals, which had been supplied with water

large proportions, ranches of large acreage being cut down to small holdings, and in some cases entire ranches disappeared little by little, inclusive of barns and buildings, leaving the owners destitute. At Tempe the river cut into the banks east of the Tempe Buttes, which protect the town on the north side against the river, carrying away many acres of valuable farm land. Considerable apprehension has been entertained by the citizens of that

locality, who fear that the river will form a new channel to the south of the Buttes and through the heart of the community. At Roosevelt, Arizona, where the engineers of the Reclamation Service have been actively engaged during the past months on the preliminaries to the construction of the great Roosevelt dam, work on the power canal and the operating of the cement mill were seriously interfered with as a direct result of the exceptional weather conditions. Cut off from all communication with the outside world for days at a time, it was with the utmost difficulty only that the large construction camps were supplied with food, forage, fuel, tools, and other supplies. The stage roads from Mesa to Roosevelt and Globe to Roosevelt presented for months the sorry spectacle of innumerable abandoned freight wagons, mired to the hubs, loaded with goods of all kinds, among them oil tanks with fuel oil for the government cement mill. That portion of the road from Mesa to Roosevelt which was constructed by the Reclamation Service at considerable expense, suffered but little from washouts. Rumors which were circulated some time ago to the effect that it had been washed out over a distance of eighteen miles are without foundation.

A glance at the records of the Weather Bureau becomes of interest in this connection. Throughout the central portion of Arizona and especially at the high elevations, the precipitation during January, February, March, and April has been marked by frequent and unusually heavy rainfalls. The Phoenix record shows a rainfall of 3.31 inches during January; 4.64 during February; 2.38 inches during March, and 2.59 inches during April, a total of 12.92 inches for the four months. This represents an accumulated excess of 10.04 inches over and

above the average for the same period during the past ten years. The normal annual precipitation at Phoenix being less than 7 inches, it will be noted that the accumulated excess for the period January 1 to April 30, 1905, as given above, is in itself greater than the yearly normal. The number of rainy days observed during the four months referred to is 48; cloudy days, 78; clear days, 42. Of this February had 14 rainy days, 22 cloudy days and only 6 clear days. Indeed, exceptional records for the Salt River Valley! On the high plateaus the records are also remarkable, the precipitation having amounted to as much as from 25 to 37 inches of snow in different localities, during single months of the period under consideration. The large snowfalls in the mountains are responsible for the fact that the rivers of Arizona toward the end of May were still discharging large quantities of water. On many peaks snow remained till late in May.

It is estimated that the discharge of Salt River above its confluence with the Verde has averaged during February and March in the neighborhood of 10,000 cubic feet per second. The flow during these two months alone would have been ample to more than fill the projected reservoir at Roosevelt. It is of peculiar interest in this connection to note that observations by engineers of the Reclamation Service indicate a marked rise in the underground water level in the Salt River Valley, and a gradual diminution in the amounts of salts and mud contained in the river water during the long period of high water. While accurate figures on this subject are not yet available for publication, it is expected that the data collected will lead to conclusions of particular interest to the irrigator as well as to the scientist.

EUROPEAN STUDY FOR FORESTERS

BY

T. S. WOOLSEY, JR.

Forest Assistant, Bureau of Forestry.

WITH our insufficient forest literature and meagre understanding of the subject, a short period of travel may be said to be almost indispensable to a thorough study of forest management. We have no demonstration forests and many of our forest school professors have never themselves seen European forests. To this is added the fact that our young foresters are sometimes confronted by problems puzzling even to an expert of twenty years' experience. Other countries have set us an example which may be well followed. Japanese forest students are to be found in Germany, France, and in India. English students from Coopers Hill formerly spent six weeks on tour in Germany and a few weeks in France; recently eight months' detailed work under a German forester has been added to the educational requirements. German students, it is true, seldom study outside their own states. Each state has its own particular method, long established, and they have not so much need of foreign study. At their schools during good weather, the Saturdays are usually spent in the forests of the different districts. Yet one of the foremost German professors told me that he had learned a great deal, both in India and Japan. If a German professor finds such trips worth while, how much more valuable would they be to the American forester?

Granted that American foresters recognize the necessity for study abroad, why is it that so few are going? Of the forest school graduates now in the employ of the United States Bureau of Forestry, there are only a few who have had European training. There are three chief reasons: (1) The present number of trained men is insufficient to properly

handle the work. The demand for trained foresters is greater than the supply. In a few years this shortage will be supplied by the new men pouring out from the schools. There will then be greater competition and only the well trained men will secure employment. This will naturally lead to a more thorough preparation by European study. (2) At present the desire to begin work as soon as possible and hence partake in the early advancement undoubtedly prevents some men from studying abroad. The fact that the right sort of study abroad will make better all-around foresters ought to deter men from such a view. It is quite within the power of government and state management to count time spent in European study as actual service. This is not unfair, and is the method of the more advanced universities. If the ability of two men is equal and one spends time in practical work, which the other puts into studying new methods, the employer would probably get better results from the latter of the two men in the long run. (3) Want of funds is perhaps one of the greatest hindrances. Under the present rules a man must consider loss of salary while on leave, as well as his extra expenses, and in addition to this a lower salary due to deferred promotion, owing to absence. At present the leave of members of the Bureau of Forestry is wiped out at the end of each fiscal year. In the Philippine Bureau, leave is cumulative up to three years. With this privilege in the United States (applicable only to leave taken for purposes of study) a man could spend three months in Germany drawing full pay which would almost pay for his trip. In time it might even be possible for men to be sent abroad on a collaborator's salary

and expenses, in order to report on special subjects. This would benefit the men and at the same time add to our scanty forest literature. When Indian forest officers are willing to spend their leave in study, they receive a travelling allowance, as well as their full pay. In order to induce European study it might even be desirable to require a monograph on some European system before advancing a man to pay of \$1,500 per annum.

One of the objections to the run of German foresters is that they find it hard to accept new and advanced ideas on thinnings, reproduction, etc. They perhaps read about such topics but do not become familiar enough with the problem to actually put it in practice. We might guard against such stagnation by founding a short post graduate course at one of the best schools and require attendance from men in government employ after some years of service. In such a short course only new and important topics would be discussed. By such personal discussion men tucked away on forest reserves would be enabled to keep in touch with the latest ideas far better than by reading. Such a system would be in line with the war college which our navy has established at Newport.

The question often arises whether a man should study abroad immediately after graduation from a forest school, or later. From the employer's standpoint the former is better. Fewer mistakes would be made. From the student's standpoint it seems better to engage in practical work for a year or so before completing his technical education. After two years of hard study at a forest school, most men begin to tire of books and want to put their ideas into practice. After a year's work they are in a better position to know just what they want to study. It is not necessary for the graduate to spend a long time in one country. With his forest school training to start with, four to five months would be sufficient for Germany; the

first month spent in one place studying the language and the details of the management of that forest. With the details of one forest well in hand, a comparatively hurried tour will be of far more value. It seems to me that Americans are apt to make far too hasty tours, and this without a preliminary month of preparation. It is a fact that spending only a few hours in a forest when on tour often gives one a false impression. It is only natural that the forester should always show his best reproduction first and thus, in a too brief stay, a visitor does not see where and why the reproduction failed—which is perhaps more instructive than seeing the successes. On one slope the spruce has succeeded, but look at the opposite side and we only find failure. Two Americans not long ago made this very mistake. They wanted to see a large variety of forests in a short time. They were usually driven through the best portions, took a few pictures from the carriage, and rushed off to the next place. Their antics lessened the German respect for American foresters. On the other hand, the "do a few places thoroughly" method is hardly the best, for the forest school graduate who has had a year or so of practical experience. Seldom is a stay of over three days profitable compared with going on to a new forest. Personally, I found European travel so instructive that I should strongly recommend even a short trip of two months, rather than a longer trip "when there is more time." With a sensible amount of time at one's disposal, say seven and a half months, I should advise four and a half months in Germany and three in France. This is taking for granted that a man knows something of both languages. Men who have visited France claim that the French methods are more adaptable to American conditions; that there is more natural reproduction and less planting. On the other hand, the German forest literature is so superior to the French that more time ought to be devoted to Germany.

Unless a man wishes to make a special study of management on a large scale and has plenty of time at his disposal, a trip to India specially for the study of forestry seems inadvisable. In a trip of five months at least two months of this must be spent in travel. An inexperienced man going into camp on his own hook runs considerable risk of catching enteric fever. In order to see the forests properly, it is necessary to provide a camping outfit and servants, so one man's expenses will amount to \$150 or over per month. With three men making the trip and travelling second class on the boat, the expenses might be reduced to less than \$100 per month, but it would entail some risk and hardship. In scientific lines I consider the United States already equal to, if not ahead of India. For men anticipating practical rather than scientific work, such a trip offers much. Certain common sense principles pervade Indian forestry, and these will be of lasting value and of direct application in the United States. On the purely practical side Indian forestry is at present preëminent. The financial working of the forests is closely scrutinized by the local governments. Possibly the financial importance of forestry has been made to take too prominent a place and has led in some cases to over-cutting. Perhaps the quotation below, which was taken from a recent issue of an Indian newspaper, illustrates how the forests are regarded:

"However, while fully recognizing that the decrease in sales of timber and fuel in this particular division was 'unavoidable,' and admitting that the various measures of improvement undertaken entailed considerable expense, one is inclined to regard a situation in which the net receipts of the department dropped by nearly 2½ lakhs 'as anything but satisfactory.' The Conservator and his subordinates are therefore once more earnestly exhorted to remember the fact that they are—timber merchants."

This idea pervades the administra-

tion and hence the practical side of every measure is most carefully weighed in the light of the expected financial results. By a trip to India one learns the ordering of forest business on a large scale; you see the best first protection in the world, practical silviculture, the regulation of grazing, the danger and abuses of over-felling, natural reproduction over large areas, you learn the results of certain kinds of large scale working plans—you learn many things, most of which have direct application in the United States. Opposed to these is the amount of time and money spent in travel, danger to health, and lack of available literature. It is almost impossible to secure copies of working plans for the reserves visited, or in fact any publications, similar to those which our government distributes free for educational purposes. Furthermore, I believe that after 1910 or thereabouts the same principles could be learned here in the United States. Japan is also a possibility for study. If her forest service is as good relatively as her other services, there is every reason to believe that much of value could be learned there.

The success of a European trip does not lie in the number and excellence of the notes recorded so much as in the broadening and rounding off of a forester's *judgment*. By seeing forests of all descriptions he begins to get the forestry eye as regards thinnings and reproduction, which it is now impossible to get in the United States. In making a hurried tour one is apt to think that he understands conditions before he really does. This is especially so as regards thinnings, and my personal experience leads me to recommend the actual marking of trees. It is surprising how simple thinnings seem and yet the number of mistakes one makes when personally executing them.

The notes taken will no doubt prove valuable and it is essential that they should be systematic. I should recommend the card catalogue method with

the following headings printed at the top of each 4 by 6-inch card: Country, Locality, Authority, Subject, Date. It is essential to know the authority, as in looking over a series of notes on the same subject, they will almost invariably contradict. Hence to properly weigh them one must know whether a forest guard or a forester is the authority. Photographs will prove ex-

pensive but are one of the best means of note taking—even if of small size.

To one who is pessimistic regarding American forestry, it will be cheering to see that even in the older countries errors are not unheard of—in fact, it might almost be said that forestry is made up of mistakes—and their correction!

THE EFFECT OF FOREST COVER UPON STREAM FLOW

PART I.

GENERAL FACTORS GOVERNING STREAM FLOW

BY

W. B. GREELEY

Forest Assistant, Bureau of Forestry.

IN the current discussion of the relation of forests to stream flow there is a danger of overestimating the influence of forest cover upon the character of a stream to the exclusion of other factors of equal or greater importance. It is a mistake to assume that the wooded or denuded condition of a watershed is of necessity the controlling factor in determining the behavior of the stream; that a forested stream is necessarily regular in flow and a deforested stream necessarily irregular. In any discussion of this subject, it must be recognized at the outset that forest cover is but one of a number of far-reaching factors whose combined influence produces a stream of a given character; and great care must be taken not to attribute to the presence or absence of forest cover upon a drainage basin results which may be due primarily to other causes.

Now there are two elements which enter into the flow of every stream:

(1) Surface run-off, or the water which on account of the steepness of the slopes, the impermeable character of the surface, or the saturated condition of the soil, does not sink into the

ground to any appreciable depth, but flows rapidly off the surface and reaches the stream almost immediately after precipitation.

(2) Underground seepage, or the water which on account of the moderate slopes of the basin, the porous character of its surface, or the dryness of the exposed soil or vegetable litter, is able to sink into the ground to a greater or less depth instead of flowing at once over its surface. Such water may remain in the soil itself, seeping gradually into the channel of the stream. Or it may penetrate through the upper, permeable layers of rock, feeding springs and other underground sources of stream supply. In either event, the water which becomes underground seepage reaches the stream channel gradually and slowly, often several months after its precipitation upon the basin.

The flow of every stream is made up in part of surface run-off, in part of underground seepage. Underground seepage, it is evident, forms the permanent, stable supply of a stream; surface run off, its temporary, changeable supply. As the proportion

of surface run-off in the total supply of a stream increases, it becomes changeable, flashy, with alternating periods of very high and very low water. As the proportion of underground seepage in the total supply increases, the stream becomes stable, permanent, tending to maintain an even, uniform flow throughout the year. The relative proportion of surface run-off to underground seepage in the total supply of a stream is, therefore, the main factor in determining its character as regular or irregular and its economic value for power, irrigation, or city supply. Any feature of the drainage basin which tends to convert precipitation into underground seepage helps by so much to make the stream regular and uniform in flow; and any feature which tends to shed precipitation as immediate, surface run-off, helps by so much to make the stream irregular and changeable in flow.

Forest cover is, then, but one of many complex and inter-related factors which influence the character of a stream. The more important of these factors may be briefly summarized as follows:

(1) Precipitation, its amount, its character as rain or snow, and the evenness of its distribution throughout the year. Gentle rains, well distributed over many months, tend to maintain constant underground seepage and equable stream flow, no matter what the character of the drainage basin may be. Heavy seasonal storms, on the other hand, especially when precipitation is confined to a few months in the year, flood the streams with surface run-off and cause changeable, intermittent flow. This condition in its extreme type is illustrated in regions having distinct wet and dry seasons like the southwestern portion of the United States where streams for much of the year are either practically dry or in flood. Other conditions which favor natural storage may modify to some extent the effects of

uneven rainfall but can never wholly counteract it.

(2) The topography of the drainage basin.

Rough topography, with steep, direct side slopes, tends of necessity to the rapid discharge of precipitation as surface run-off rather than its gradual absorption over the basin as underground seepage. Moderate topography, on the other hand, with gentle side slopes, retards the surface run-off and converts a larger proportion of the precipitation into underground seepage, the permanent, stable supply of stream flow. Streams of rough topography, moreover, have rapid fall and torrential current; those of moderate topography, slow fall and sluggish current, factors which affect directly the quickness with which a heavy precipitation upon the watershed is felt along the lower levels of the stream and its character as regular or changeable.

The simple or complex character of the topography is another important factor affecting the evenness of stream flow. Streams with few tributary basins, and those short, sharply defined, and direct in course, such as are found usually in the newer geological regions, rise and fall rapidly in response to variations in precipitation. Those, on the other hand, with many tributaries of the long, winding, indirect character common in the older, heavily eroded sections, discharge flood waters over a much longer period with less sudden and sharp variations in flow.

Finally, the presence or absence of lakes, ponds, or swamps in the drainage basin is a very important topographic feature in its bearing upon the behavior of the stream. Every such area acts as a natural reservoir, storing and holding flood waters, feeding them out gradually, and thus equalizing the flow of the stream throughout the year.

(3) The geological character of the drainage basin. The character of the surface rock has much to do with the

immediate shedding of precipitated water or its absorption and storage as underground seepage. Hard surface rocks of dense texture, like the granites and gneisses, tend to shed rainfall at once as surface run-off. Softer rocks of porous texture, like limestone, favor the absorption of rainfall and its gradual transfer to the stream as underground seepage. The character of the mother rock, moreover, determines very largely the nature of the soil, its depth, porosity, its power of absorbing and retaining water, all factors of prime importance in their bearing upon the disposal of precipitated water as rapid surface discharge or gradual absorption to underground sources.

(4) The fourth of the important factors governing stream flow is the character of the vegetation upon the drainage basin, with special reference to the influence of forest cover. Forests have always been regarded as connected in some way with the protection and preservation of water supply. As this vague belief has been superseded by more exact investigation, certain definite influences have been attributed to forest cover in its bearing upon stream flow. Few of these influences can be said as yet to be clearly established, and many are combated by able authority. It will be attempted here simply to summarize the more important facts relating to each.

In the first place, it has been claimed that forest cover on a drainage basin actually increases the amount of water available for stream supply by retarding evaporation from the ground. This influence is attributed to the somewhat lower temperatures prevailing under forest cover and to the protective influence of the tree canopy and litter in insulating the soil from the sun's rays and thus checking the strength and directness of the evaporation force. Other reasons advanced are the high

relative humidity maintained in the atmosphere by forests through their shade and active transpiration from the leaf surface, and their influence in breaking up air currents and protecting the ground from the drying effect of wind. A series of German experiments, representing conditions both in the woods and in the open, shows that the total evaporation under forest cover averages but 44 per cent of the evaporation from unprotected soil.¹ Mr. Rafter, reckoning the amount of evaporation as the difference between the total annual precipitation upon a given basin and the estimated annual stream discharge from the same area, concludes that a difference of five or six inches in annual evaporation, or about 25 per cent, can be distinguished between a forested watershed like the upper Hudson and a deforested basin like the upper Genesee.²

On the other hand, the opposing claim is made that actually less water is available for stream supply on a forested than a deforested basin. This is due to the interception of 25 or 30 per cent of the rainfall by the foliage of a forest and its direct evaporation into the air, and to the large amounts of water consumed in the process of tree growth and transpiration. In this connection it is urged that variations in the amount of evaporation from drainage basins are due primarily to differences in temperature rather than to differences in soil conditions or forest cover. Mr. Vermeule cites a large number of eastern streams which have practically the same forest conditions but which show a range of eleven inches in the total annual evaporation. In nearly every instance increased evaporation accompanies higher mean annual and mean summer temperatures. In like manner, a number of eastern streams having a range in the total percentage of forested basin from 14 to 44 per cent show practically the same evaporation, the reason

¹cf. Bulletin 7, U. S. Bureau of Forestry, page 97.

²cf. Proceedings American Forestry Association, vol. xii, page 149.

assigned being similarity in prevailing temperatures.¹ Any rise in temperature quickens evaporation by lessening the humidity of the atmosphere and thus making possible the absorption of much larger quantities of moisture.

Whatever influence forest cover may exert in this direction is undoubtedly secondary to that of temperature, the primary factor in controlling evaporation. In the present uncertainty on this subject, no absolute conclusion as to the influence of forest cover can be drawn.

The second influence attributed to forest cover upon a drainage basin is the equalization of stream flow by transforming surface run-off into underground seepage. This is due in part to the mechanical obstruction of surface water by the leaves, branches, litter, roots and humus of the forest. Any such obstruction lengthens the time required by precipitated water to reach drainage channels and tends to convert a larger proportion into underground seepage. Underground seepage is increased, in the second place, by the marked capacity of forest litter and humus for absorbing and holding rain water. The porous, spongy character of humus not only enables it to absorb and hold two or three times as much water as the most absorbent soils, but it greatly increases the porosity and absorptive power of the mother soil with which it becomes mixed by gradual decomposition.

The equalizing influence of forest cover is exerted in another important respect by delaying the melting of snow and preventing, by its thick mulch of humus and litter, the freezing of the soil beneath during the winter months. It is claimed that the melting of snow upon open, exposed mountain slopes is often ten times as fast as upon forested slopes in the same region.² Moreover as the snow melts it stands

a much better chance of absorption and filtration to underground sources in the porous, unfrozen ground under the forest than on the hard, frozen soil of the exposed slopes. This protective influence is seen most clearly in the Rocky Mountain region which is subject to the warm Chinook winds of early spring.

The exact extent of the equalizing influence exerted by forest cover in each of these ways it is of course impossible to determine. Of their combined effect in equalizing stream flow much substantial evidence is cited. Such evidence is furnished by the lessened number and severity of floods upon forested as compared with denuded basins, by the greater premanency of flow from springs and other underground sources, and by the better sustained stream supply during months of little or no precipitation. As illustrating the usual difference between forested and deforested streams, Mr. Vermeule cites³ figures from the forested Passaic and the deforested Raritan of New Jersey, showing for the former a marked superiority in evenness of flow, less water proportionately being discharged immediately after heavy rains and more proportionately during dry months which follow. A forested basin thus shows a marked tendency to store flood water and discharge is more evenly and uniformly into the stream channel than a denuded basin in the same region. An interesting case from California is cited by Mr. Manson.⁴ Of two small tributaries of the Yuba River, of approximately the same drainage area, one is well covered with timber and brush, the other being largely denuded. Both streams were gaged in September, 1900 after three successive seasons of deficient rain. The forested stream showed a minimum run-off for the 120 days of low water of 113 second feet, while on

¹cf. Reports State Geologist of New Jersey, 1899, page 145; 1894, page 333.

²cf. Water Supply and Irrigation Papers, Division of Hydrography, U. S. G. S., No. 46, page 46.

³cf. Report State Geologist of New Jersey, 1899, page 162.

⁴cf. Bulletin 7. U. S. Bureau of Forestry, page 136.

the denuded basin the discharge during the same period was practically nothing.

This is by far the most far reaching and generally accepted influence of forests upon stream supply. Its extent and limits under varying conditions are still unknown. Its ability to counteract the effect of other unfavorable factors, such as steep topography and unevenly distributed rainfall, is still largely conjecture. We can, however, state with certainty that forests exert a powerful though ill defined influence in this direction.

A third distinct influence has been attributed to forest cover upon a drainage basin, namely, the checking of erosion upon the watershed and the consequent silting of stream channels, where the silting of storage reservoirs. Forest cover is supposed to check erosion by lessening the amount and velocity of surface run-off. Furthermore its mat of roots, humus, litter, moss, and undergrowth tends to hold the soil in place and protect it from the wearing action of such water as is discharged over or near the surface. Evidences of this influence are at hand in any mountain region of the United States. It is especially marked in the Southern Appalachians in the turbidity of streams which drain denuded basins, the choking of their channels with silt, and the often destructive deposits of mud and debris over level bottoms along their lower courses. This factor has a direct bearing upon the reclamation project in the west valley bottoms, and storage reservoirs. is often a very serious obstacle to the control of streams.

Not only does direct erosion of the exposed surface follow the removal of forest cover, but this loss of soil means ultimately the loss of the porous surface layer in which rainfall is absorbed and converted into underground seepage. Loss of forest cover and loss of soil go together. As the process of erosion goes on, impermeable strata are exposed, resulting in the rapid and destructive discharge of

precipitation as surface run-off. Forest cover on a drainage basin, therefore, not only checks directly the silting process so destructive to stream beds, valley farms, and reservoirs, but also by conserving the porous soil layer affects directly the regularity of stream flow.

Now it must be constantly borne in mind that these influences of forest cover, in their present status, must be classed as "attributed" rather than demonstrated or proved. Available material bearing upon them consists largely, up to the present, of theoretical discussion. Such experimental data as has been collected is fragmentary and inconclusive. Among investigators there are radical differences of opinion. At the same time we may consider the general equalizing effect of forest cover upon stream flow as well established in principle, though vague and ill defined in detail application.

Another point cannot be too strongly emphasized, that forest cover is but one of many factors in a drainage basin whose combined influence produces a stream of a given character. Great care is required not to attribute to forests influences which are due primarily to other factors; and likewise not to assume that forests exert no such influence when it simply may be counteracted by other and more powerful factors.

It is moreover impossible to make generalizations which can be applied to a wide range of natural conditions. This problem should rather be attacked piecemeal, by careful, detailed studies of individual streams and limited areas. Such studies should cover all the features of the drainage basin which may affect stream flow, precipitation, topography, geological conditions as well as forest cover, together with the behavior of the stream as shown by continuous discharge measurements. The various factors which govern stream flow are so closely interrelated in their action that it is impossible to assign to each its ex-

act influence in producing the final result. All the more necessary is it, therefore, before attributing any specific influence to some one factor like forest cover to consider the probable influence of all the other factors involved and their bearing upon the

one factor in question.

In a subsequent paper a brief account will be given of an investigation of two small drainage basins in eastern New York, in which the attempt was made to approach the question in this way.

A SUCCESSFUL ROOT PRUNING DEVICE

Now in use at the Government Nursery in Nebraska

BY

L. C. MILLER.

Forest Assistant, Bureau of Forestry.

BY a careful consideration of the best nursery practice to be followed out in the Bureau Nursery at Halsey, Neb., where there is a total seed bed area of two and one-half acres, with a capacity of two and one-half to three million seedlings annually, it is found that seedlings should be two years old before planting to their permanent sites in the sand-hills. It is also considered essential to produce this two year stock at a minimum cost per thousand in order to make the initial cost of establishing the permanent stand as economic as possible.

Transplanting increases the cost of seedling production so materially that it is not considered practical to transplant the vast quantity of seedlings grown in the Halsey Nursery, and hence it is considered advisable to rootprune all yearling stock and allow same to remain in seed bed for another year, at the end of which time the seedlings will have produced a vigorous root system equal, or nearly equal, to transplanted stock.

Until this spring, rootpruning has not been satisfactory, owing to the fact that no suitable device had been hit upon to do rapid, and at the same time, satisfactory work. Spades have been used, but with such a tool the



Fig. 1. Root pruner, as it appears when not in use.

lateral roots only can be cut, while the essential root to be pruned is the long toproot which is formed by most all the coniferous species.

In the San Gabriel nurseries, near Pasadena, California, a tool has been devised for pruning, which consists of a combined perpendicular and horizontal blade, to which a handle is attached, and this is pulled through the soil by one hand. This tool works very satisfactorily in a small nursery like the one near Pasadena, but it is

A. Scott, I succeeded in making a root pruner, which has proved highly satisfactory. This is shown in figures 1, 2 and 3.

The important feature of this tool is the cutting blade. This is one inch wide and one-eighth of an inch thick, and made from a first class piece of steel. It is U shaped, and the perpendicular sides are seven inches long, and the horizontal base is six inches long. This blade is riveted to substantial collars, which are made to



Fig 2. Root pruner in use, operated by two men.

entirely inadequate in a nursery like the one at Halsey, where millions of seedlings are to be pruned annually. The great necessity for some practical device for rootpruning was made apparent to me while inspecting the nursery and planting at Halsey in April, and I set to work to devise a tool for this purpose. With the assistance of Mr. F. W. Beslev, who had temporary charge of the Halsey Station during the absence of Mr. C.

fit on a Planet, Jr., garden hoe frame. This is a single wheel frame, and in order to have the wheel run between the rows of trees it was necessary to change it to the outer side. I am satisfied that this device attached to a double wheeled frame would make a more substantial tool. The cutting blade is filed to a keen edge, and kept so during the pruning operation. By having such a thin blade, and keeping it sharp, there is practically no resis-

tance offered in passing through the soil, and all roots are cut with out the usual injury done with a heavier tool. The blade for this tool was hammered from a hay rake tooth and proved to be just the quality of steel for the purpose.

Two men are required to do satisfactory pruning, one to guide the tool, and one to pull it through the soil. By cutting to a depth of six inches, it requires considerable power to operate, but it is found that by tying a rope on the frame, that one man can pull the pruner with considerable rapidity, but it requires considerable strength, and the process is by no means child's play, and a man who has rootpruned all day will feel as if he has earned his wages.

By the use of this tool, two men can prune from 100,000 to 150,000 in eight hours. This is extremely satisfactory speed when it is compared with other processes.

Immediately after pruning the beds are carefully raked over in order to level up the soil in the beds, which is more or less disturbed at the surface. This operation does not require a great deal of time, and is considered highly beneficial to the young seedlings.



Fig. 3. Raking beds after pruning has been done.

THE UP-BUILDING OF NEVADA

Third Anniversary of the Reclamation Act Celebrated
by the Formal Opening of the Truckee-Carson Project.

THE third anniversary of the passage of the Reclamation Act was fitly celebrated by formally turning water on 50,000 acres of land in Nevada, the first area to be benefitted by the provisions of this act.

The story of the construction of the Truckee-Carson project with its wonderful network of canals uniting the four principal drainage basins of the state, of the expenditure of \$9,000,000 and the ultimate intensive cultivation of more than 400,000

acres of land now barren and desolate, has been told again and again. Far up in the foothills of the snow-crowned Sierra Nevadas half a score of lakes will be utilized as reservoirs to store the flood and excess waters which flow down the mountain sides, and down in the valleys imposing dams will hold back millions of tons of water, turning rivers back upon themselves till great artificial lakes are formed, or diverting the water into channels more convenient for

the use of man. Lake beds will be drained and transformed into agricultural fields, and thousands of miles of ditches and laterals will distribute water over the land.

With the exception of a narrow fringe on the northern and southern borders of the state, Nevada lies in a basin from which water escapes only by evaporation. Humboldt River, rising in the mountains which divide Utah from Nevada, drains the entire northeastern portion of the state, carrying its waters several hundred miles to a wide basin near Lovelocks where

During all the idle centuries of the past these lands have been gathering richness in the silt washed down from the mountains, which has gradually filled up the valleys and prehistoric lakes, forming an alluvium of great depth and fertility.

The completed system of reservoirs in connection with the Truckee-Carson project will assure an annual water supply, even in low water seasons of 800,000 acre-feet, besides a portion of the streamflow which cannot be stored. As the country becomes more thickly settled and land



Job's Peak from Dressler Reservoir Site, California, showing one of the sources of water supply for the Truckee-Carson project.

it spreads out in a large lake and evaporates. The Truckee, Carson and Walker rivers created by the melting snows of the Sierra Nevada Mountains in California, flow east into Nevada where they, too, form lakes which have no outlets. The numerous mountain areas are subject to storms, giving rise to torrential streams which rush down the steep slopes and pile debris out upon the desert, into which the water sinks.

values increase, the underflow of streams and artesian water will add to the supply and increase the irrigable acreage. Hydrographers, who are thoroughly familiar with the water supply of the state, believe that water can be developed for the irrigation of fully 1,600,000 acres of land.

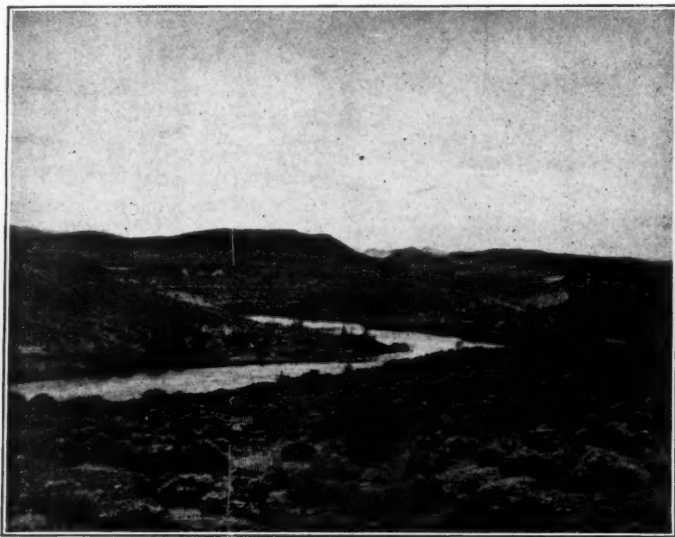
The marvelous manufacturing possibilities of the rivers in the shape of latent horse power cannot be estimated. The Truckee River alone in

its one hundred mile course falls 2,300 feet. The power which may be developed by regulating these streams will not only be valuable in connection with manufacturing interests, but can be transmitted electrically hundreds of miles, operating mines and electric roads, raising underground waters, and lighting cities and towns. A study of Nevada's water supply will be a revelation to those who know only that it is the driest state in the Union.

It was not by chance this section was singled out as the field for the

the pick for the hoe. So bountiful were the returns from the soil where water was applied, and so fabulous the prices which the hay and vegetables brought in the little mining towns of the silver region, that these farming communities grew and flourished.

Remote from the large centers of civilization, these dwellers of the desert developed a sturdy citizenship. Some of them have spent years of their lives and large sums of money in surveying and prospecting the resources of the state. Their patience



Lower Carson Reservoir Site, from Dam Site. (Truckee-Carson project.)

first demonstration of the practicality of the Reclamation Act. Nevada has guarded its treasures with an exterior so forbidding that the pioneer hurried past its doors. The discovery of placer deposits in its streams soon after the California excitement, was followed by a wave of gold-mad speculators which receded almost as suddenly as it came, but here and there in its wake tiny flecks of green marked the abode of the stranded miner, who forced by necessity, had exchanged

and persistence added to the thorough knowledge of Nevada's every possibility, which had been gained by L. H. Taylor in eight years of investigation for the Hydrographic Branch of the Geological Survey, resulted in the formulation of a comprehensive plan for the redemption of the state. From the countless sands of her sage brush deserts the empire which their fancy had builded is rising, and down through the ages these works will stand a monument to their foresight

and to the ingenuity of Supervising Engineer L. H. Taylor.

When the scheme for Nevada's resurrection was laid before the Department, the Secretary of the Interior tentatively approved the plan and set aside \$2,740,000 of the reclamation fund with which to initiate the great work. A portion of the project which would form a complete system was immediately laid out. It consisted of a canal thirty-one miles long to take the waters of the Truckee River over into Carson Valley, where a storage reservoir with a capacity of 286,000 acre-feet was designed. Four and a half miles below this reservoir site the combined waters of the Truckee

Owing to the wise provisions of the Reclamation Act, the colonization period under the Truckee-Carson project will differ from that which has taken place in any community on our continent up to the present time. Whenever there has been a great immigration movement for any reason, a host of speculators has rushed in, skimmed the cream and departed. The man who takes a forty or eighty-acre tract under this project must come to stay. He may not commute his entry after living a few months on the land, but must prepare the tract for cultivation, till the soil, paying his annual stipend of \$2.60 per acre for ten years before title passes from the



Scene in Mason Valley, near Wabuska, Nevada, showing character of land that is to be irrigated.

and Carson Rivers are to be led out upon the plains in two canals, one on each side of the river. The north side canal will have a capacity of 400 cubic feet per second and will irrigate approximately 40,000 acres of land, and the south side canal, with a capacity of 1,500 cubic feet per second, will supply water to about 160,000 acres. It is a portion of these lands which were formally opened to the public on June 17, and before another season the first payment from 50,000 acres will be replaced in the original investment.

government.

The eagerness with which the land is even now acquired by practical farmers, and the favor in which the first experiment of the government to reclaim its arid lands is regarded, is apparent in the vicinity of Wadsworth and Hazen. The desert is already dotted with buildings of prospective owners, and all along the railroad, at short intervals, new hamlets are rising. When once the great benefits of this initial work are fully demonstrated, Nevada will experience an immigration movement which has had

no parallel in the history of our country, a movement only limited by a capacity which cannot now be estimated.

As planned the Truckee-Carson project will supply water to 385,000 acres in excess of the land irrigated in Nevada at the present time. The average value of irrigated land in the United States is \$47 per acre; the acre to be irrigated by the Truckee-Carson project will therefore add \$18,195,000 to the taxable property of the state in land values alone. According to the census report of 1900 the average annual income from irrigated land is \$15 per acre. On this basis an income of \$5,775,000 per annum will be added to Nevada's agricultural wealth. The value of two crops will exceed the cost of the entire project by \$2,550,000. That this is a conservative estimate readily will be seen when it is remembered that irrigated potatoes in many portions of Carson Valley now give returns of \$150 per acre. Experiments by the Department of Agriculture show that the Truckee and Carson valleys are peculiarly fitted for the culture of sugar beets, hops will yield abundantly

and all the hardier fruits produce crops of remarkable flavor and size.

The mineral wealth of the state has hardly been prospected. With added transportation facilities and cheaper supplies, mines which are now abandoned will be worked with profit, new veins will be discovered, and markets for farm and manufactured products be increased.

Of the possibilities now lying latent in these sage brush plains no mind can prophesy. Water is the mystical wand which is to unlock this great storehouse of nature—the magician who wields it, the civil engineer, and where but a few years ago death mocked the daring pioneer and unknown graves dotted the plain, the life-giving water will be so regulated that neither drouth nor flood shall bring want to the settler; churches and schools will flourish, and the farmer will plant his crops with the certainty of bountiful harvests. From time immemorable irrigation has been synonymous with higher civilization. It creates loftier standards of living, makes prosperous communities and contented citizens.

THE WATER LEVELS OF THE GREAT LAKES.

THE water levels of the Great Lakes and the chagnes which have taken place during the last few decades are a matter of great public interest. Lake carriers commonly believe that the lake levels have lowered considerably and that the changes are attributable to the deepening of the connecting channels, and, perhaps, also to diversion through the Chicago Drainage Canal. The engineers of the U. S. Geological Survey have been investigating the in-flow to the Great Lakes, while the U. S. Lake Survey has measured the out-flow from the lakes. It is found that when the rain-fall on the lake surface is taken into

consideration there is a material loss or difference between the out-flow and the in-flow. This loss is attributed to evaporation from the lake surfaces. In order to determine this more definitely a set of instruments for measuring evaporation, wind velocity, and the temperature of the air and water, will be placed on Beaver Island in the northerly part of Lake Michigan. The instruments will be placed near the village of St. James and as they are near the center of the width of the lake they will be fully exposed to the wind and will give a record of the rain-fall, wind direction and velocity, and evaporation over the

lake itself, which could not be obtained from a similar station on the main land.

Beaver Island, where the station is to be placed, was settled by the Mormons in the middle of the last century and one of the Mormon leaders had himself crowned as king and maintained an absolute monarchy for a time, until he was deposed by the authorities of the State of Michigan; but, nothing daunted, he continued virtually his monarchy and had himself elected to all the important offices in the county, including that of member of the State Legislature. About 1870, the group of islands, of which Beaver Island is the most important, was divided between Charlevoix and Leland Counties, and the self-styled monarch was finally forced to abdicate and was later murdered by one of his confederates.

The evaporation record at St. James is kept in connection with the Signal Display Station of the U. S. Weather Bureau, and is under the direction of Robt. E. Horton, district hydrographer, of Utica, New York.

What seems to be a newly discovered cause for the lowering of the levels of the Great Lakes, which is commonly believed to have taken place during the last half of the century, is brought forward in an investigation by Mr. Robt. E. Horton, of the U. S. Geological Survey. It is well known that Michigan was at one time almost completely covered with heavy forests. These have gradually been

cut away and the land cleared for agriculture.

In early days many marshes existed. Many of these were the result of beaver dams blocking the passages of the streams. These dams have been cleared out and drainage channels aggregating thousands of miles in length have been excavated. Mr. Horton has collected statistics showing the extent of deforestation, drainage and cultivation of land, and its progress from year to year, over the State of Michigan. It is found that the changes which have taken place have been sufficient according to the estimates of different authorities to decrease the average flow in the streams from five to twenty per cent. per year. It is possible that in some sections of the state the cutting off of pine timber has actually increased instead of decreasing the annual flow of the streams available for water power and other purposes. Balancing the different elements it has been found that a decrease in the depth of rain-fall, which runs off in the streams, of at least one-inch per year, has probably taken place over the State of Michigan in the past fifty years. The importance of this fact will at once be seen when it is understood that a decrease of one-inch in the run-off of the stream's tributary to the lakes means an average lowering of the lake levels from Lake Erie to Lake Michigan and their connecting channels of at least seven inches, or over half a foot.



THE RECLAMATION SERVICE

New Projects in View---Work Progress-
ing Rapidly on those Already Started

Development of Klamath Region.

Crater Lake, in Klamath County, Oregon, is one of the wonders of the wonderful West. This strangely beautiful body of water is included in a National Park, and though at present it is not easily accessible, it will prove a mecca for many of the thousands of Eastern people who will visit the Lewis and Clark Exposition at Portland this summer.

South of Crater Lake is the great Klamath Country, including parts of Klamath County, Oregon, and Siskiyou and Modoc counties, California, a land o' lakes and a territory of great possibilities. The United States Reclamation Service has found this section so promising that its engineers are planning a drainage and irrigation system to cover about 250,000 acres of excellent land.

Prominent features in the topography of this country are three large navigable lakes, Upper Klamath, having an elevation of 4,142 feet, Lower Klamath, with an elevation of 4,086 feet, and Tule of Rhett Lake with an elevation of 4,056 feet. From Clear Lake, a smaller body of water having an elevation of 4,533 feet, Lost River, a considerable stream, wanders aimlessly through a chain of fertile valleys until it empties its waters into Tule Lake.

It is a unique feature of the Klamath Reclamation project that of the 250,000 acres to be irrigated, at least half is now constantly under water of a depth varying from one to fifteen feet. In all irrigation works undertaken by the Reclamation Service, drainage accompanies irrigation as a vitally necessary adjunct, but for half the lands in this project drainage must, for two or three years, precede irrigation. It is proposed to drain off

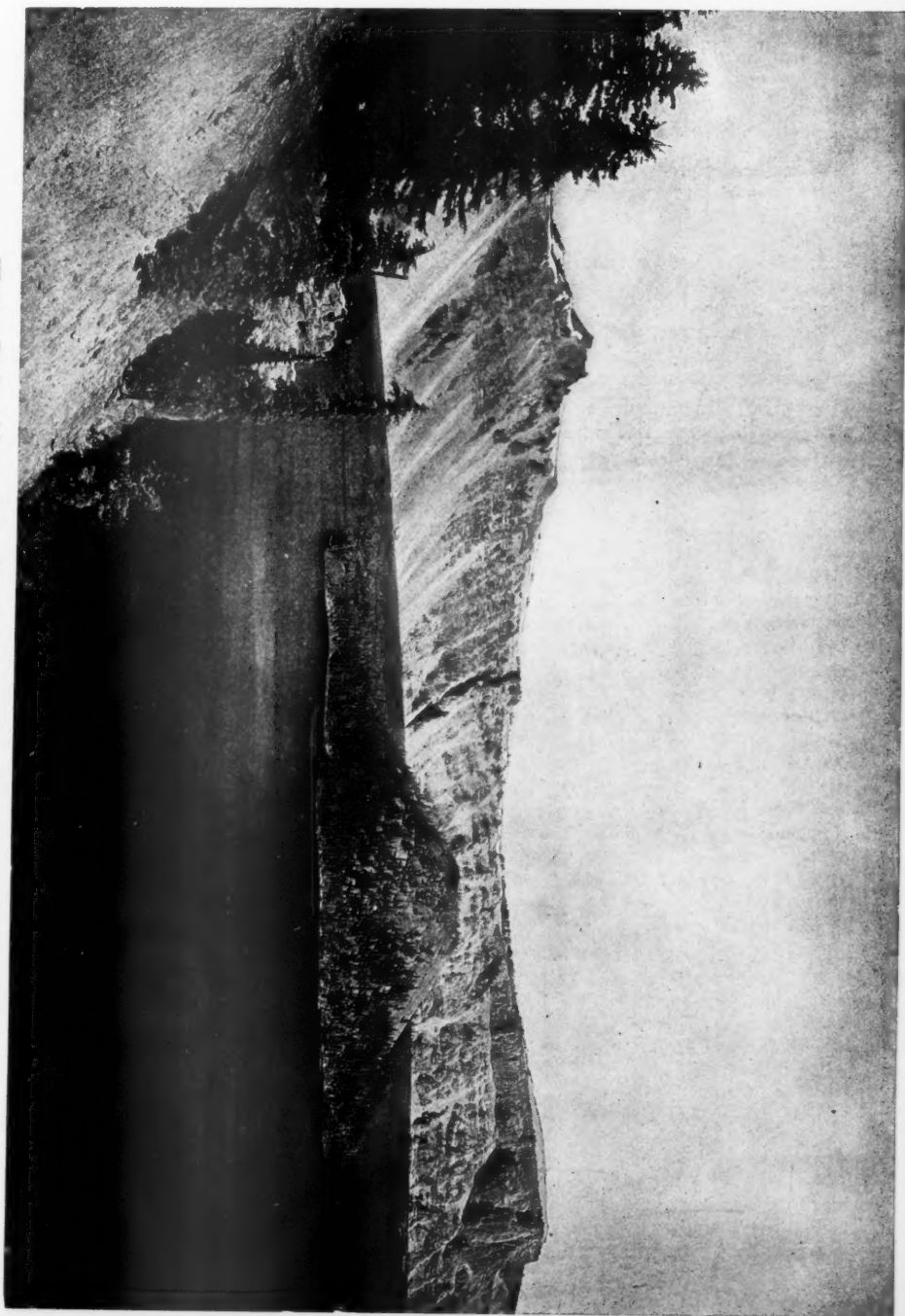
all the waters of Lower Klamath Lake and to uncover half the lands in Tule Lake, the Federal Congress and the Legislatures of Oregon and California having given the necessary permission to the Reclamation Service. The two states have ceded to the National Government all lands in the lake beds, and these lands, with the exception of the acreage now held in private ownership, will be subject to homestead entry when thoroughly drained and ready for cultivation.

A greater part of the area, 190,000 acres, under the Klamath project, will be irrigated with water drawn from Upper Klamath Lake, a natural and inexhaustible reservoir. No storage dam is required here, the lake having a sufficiently higher elevation than the lands to be watered. About 60,000 acres will be watered from Clear Lake, in California, or from Horsetly reservoir situated in Oregon.

Of the now dry lands under the project only a few thousand acres are public lands. The greater part of the lands in private ownership is held in large tracts, and, under the provisions of the Reclamation Act, those lands must be sold in small lots, as one person can purchase water for no more than 160 acres. The Klamath Water Users' Association, a corporation of land owners with a capital stock of \$3,000,000, has organized to coöperate with and assist the Reclamation Service. The office of the association is at Klamath Falls, Oregon, the county seat of Klamath County.

The Klamath Country is now without immediate railroad connection, but two companies have given assurance that they will begin immediate construction of railroads to connect Klamath Falls with the Southern Pacific

Western Border of Crater Lake, Oregon, in the Region Near the Klamath Lake Project.



line running between San Francisco and Portland.

The land owners have found it necessary, owing to the lack of transportation facilities, to confine themselves to the cattle industry and the cultivation of hay. Alfalfa yields from four to five tons per acre. The lands produce heavy crops of grain, apples, peas, plums, cherries, and peaches, and the smaller fruits are successfully grown. Sugar beets raised as an experiment, show a high percentage of sugar. Most of the vegetables, and especially onions and potatoes, yield bountifully. The streams and lakes abound with trout, while ducks of every kind and geese tempt the huntsman.

Progress on Belle Fourche Project.

Construction work on the Belle Fourche project has commenced in earnest, two camps having been established, one at the head of the inlet canal for work on that canal, and one at Owl Creek reservoir site for work on the dam and the first section of the outlet canal.

Bids have been requested for the construction of a double circuit telephone line connecting each of these headquarter camps with the town of Belle Fourche. It is proposed to drill an artesian well at each camp, as the surface water is unfit for domestic use during the greater part of the year. The buildings are so located and constructed that they can be utilized by the gate-keepers after the project is completed.

The successful bidder for the construction of the inlet canal has begun work and 1,000 barrels of cement have been received and tested. Final location of six and one-half miles of canal has been completed, and considerable surveying and other preliminary work accomplished.

The party situated at the dam site has made a general reconnaissance of the area around the dam and about 100 holes have been bored to obtain information as to the location of material and amount of same. One gravel bed containing 15,000 cubic

yards of gravel was located for use in construction work.

Stream gaging for the season was begun on April 1st, twelve stations visited and checked, gages repaired and one cable station established. New stations were established—one on Hot Creek and one on Beaver Creek.

Making a New Town in Idaho.

Resolutions have been passed by the State Land Board, of Idaho, pledging the coöperation of the state in the matter of laying out and disposing of lots in the new town of Heyburn, on the tract included in the Minidoka irrigation project.

At the suggestion of Governor Gooding the subdivisions were extended half a mile farther west than in the original design. The railroad siding of the Oregon Short Line Railway has been constructed and the depot site located.

The town was named in honor of Senator Heyburn on account of his deep interest in the Idaho projects in general and the establishment of this municipality in particular.

It is probable that the Secretary of the Interior will place certain lots in both the government reserve and the state subdivision on the market in the near future for this purpose. Practically all of the land on the north side is now taken and the people are living on their claims. Trains are running as far as the river and a large construction crew is located at the town site. Several business men are desirous of locating at this point and many private individuals have signified their wish to buy lots for residence purposes.

A committee appointed by a mass meeting of citizens for the purpose has drawn up resolutions asking for the immediate opening of the town-sites. It is recited that the settlers will be subject to great hardship, resulting from their inability to obtain supplies if the town is not opened soon, and that business men who desire to locate will go to other points. The work which the settlers might



Jackson and Emma Matilda Lakes, Wyoming.



Two Ocean and Emma Matilda Lakes, Wyoming.

obtain incident to building up the town would also be of great assistance in helping them until such time as water can be furnished.

It is probable that as soon as the necessary preliminaries, such as appraising the land, can be completed, the Department will proceed with the disposition of such areas as it is deemed advisable to throw open at the present time.

State Irrigation Under National Supervision.

In certain sections of the west steps are being taken toward inaugurating the plan suggested at the irrigation congress at El Paso, Texas, by the following declaration:

"We would not have the west depend alone upon national aid for the development of its resources, and urge the several Western States and Territories to adopt legislation providing for the formation of irrigation districts, which shall be able to raise funds by the sale of bonds, said districts to be organized only upon approval by the Secretary of the Interior, who shall employ the engineers of the Reclamation Service in the construction of district irrigation works. By this means the reclamation fund will be supplemented to the extent of millions of dollars by every state and territory, while the benefits of national administration will be vastly extended. We commend this subject to the earnest attention of the Legislatures of our Western States and Territories."

If legislation by the several arid states and by Congress is enacted to authorize and regulate such operations, there is no doubt that great benefits would accrue to the arid region. This legislation would be in line with the real intent of the Reclamation Law, which was enacted for the purpose of accomplishing by Federal aid what private capital or the states themselves could not effectually do.

The limited fund now available for reclamation purposes as compared with the enormous irrigation possi-

bilities awaiting development under it, makes it highly improbable that many otherwise feasible projects will be undertaken for several years.

The suggestion is made that the Secretary of the Interior, through the engineers of the Reclamation Service, should make the necessary examinations and plans for projects to be constructed by the irrigation districts; that contracts for the work should be let through the Secretary of the Interior, and that the funds be supplied by the sale of irrigation district bonds, the same to be expended by the Secretary of the Interior.

It is believed that legislation of this kind could be drawn so as to properly conserve the interests of the government and protect the Reclamation fund, and that it would be of great benefit in the development of the arid region.

Petition from Smith River Valley, Montana.

A petition has been received by the Director of the U. S. Geological Survey from residents of Smith River Valley, Meagher County, Montana, asking that a reservoir be constructed by the Reclamation Service on the North Fork of Smith River for the purpose of irrigating lands in that valley.

The petitioners set forth the excellent character of the land and its possibilities under careful cultivation when supplied with an adequate water supply, and the advantage which will accrue to the residents in the valley if the reservoir is constructed.

An investigation of the conditions will be made at the earliest opportunity found for doing so without retarding the work for which plans have been made and which has reached a somewhat advanced stage.

Forming a Water Users' Association in North Dakota.

Preliminary work toward the formation of a water users association under the Bismark project, North Dakota, is under way, and the meeting

of citizens and land owners held May 15, at Bismark, was well attended.

There is a great increase of sentiment in favor of the project among the land owners. Many tracts of land within the area proposed to be irrigated are owned by non-residents or by companies, but these interests are gradually coming in and many business men are purchasing lands, thereby becoming eligible to membership in the association. It is believed now that the association will be incorporated in a short time and the required

years, and by pumping in dry years. The timbered areas on the lower bottom along the river bank will also be examined to determine how much of this area should be left out of the project on account of the value of the timber or for the sake of protecting the bank from being washed away.

If, however, the land owners under the Bismarck project do not take the required steps to cooperate with the government the work will be allowed to drop for the present and the feasi-



Bench Lands, Okanogan River, Washington.



Brown Lake Reservoir Site, Washington.

percentage of land owners will have been signed up.

The preliminary work on the Fort Lincoln project will be completed soon, and preliminary plans and estimates prepared. A field party has been directed to make surveys of the proposed reservoir site on Apple Creek in order that this feature of the Bismarck project may be better defined. It is possible that two or three thousand acres may be added to the original area by this means, most of which could be supplied by gravity in wet

bility of the Fort Lincoln project will be considered.

Planning a Washington Project.

Observations of water supply and related investigations on the Okanogan project, Washington, are being pushed by the district engineers, to the end that detailed estimates of cost may be presented to the land owners.

The irrigable lands consist of 15,000 acres of varying quality, lying in a series of benches between the Okanogan River and the hills surround-

ing the Okanogan valley between the towns of Alma and Riverside. The water supply is believed to be insufficient for the proper irrigation of more than 10,000 acres, 1,500 acres of which are already irrigated.

The limited area of the tract and its location in the heart of an extensive range country, which would be dependent upon it for its winter feed, would insure a profitable and permanent market for forage. The lands are also well adapted to the production of deciduous fruits and nuts, and when cultivated in these products would yield large returns. Lands near Wenatchee, of similar character, with adequate water supply, are worth from \$150 to \$200 per acre.

The climate is mild, but some years the exceptional depth of snow prevents the feeding of stock on the range. The growing season lasts about six months and light crops of hay or potatoes can be raised without irrigation. The present value of non-irrigated land is about \$5 per acre, when irrigated, from \$40 to \$100. Three crops of alfalfa producing from four to six tons per acre are harvested and temperate fruits, small fruits, vegetables and wheat are raised. The fuel supply is practically unlimited on account of the heavy growth of timber in the hills and mountains.

Lumber for building purposes can be obtained at reasonable prices—\$8 to \$15 per thousand, board measure, at the mills, which are located at various points for convenient hauling. Good markets are found in Seattle, Tacoma, Spokane and Alaska.

On account of the possibilities for high development it is believed that the farm units will be small.

In case the investigations now in progress do not develop a material increase in the present estimates of cost the construction of the project will rest largely with the land owners and their readiness to comply with the required terms.

Studying Quality of California Waters.

The California Legislature, during its last session appropriated a sum of

money to be used in coöperation with the U. S. Geological Survey for the purpose of determining the economic qualities of the waters of the state, and a contract has just been executed by which the work shall be carried on. It provides, in brief, for the determination of the quality of the natural waters in the state of California and their adaptability for use for domestic and industrial purposes, the seasonal variation in composition, and the damage which they have sustained by reason of pollution. It is also provided that this investigation shall be under the joint direction of the Director of the U. S. Geological Survey and the Secretary of the State Board of Examiners.

The practical results of this work will be to provide the residents of the state of California with information concerning the adaptability of the various water supplies of the state for use in industrial and domestic purposes. It is a well recognized fact that the quality of water in any region determines in a large measure the industrial development of that region, and it has frequently been observed that an industry will locate at points where there is available water of a quality specially favorable to that particular industry. The water in a certain area, for example, may be of a quality favorable for use in a distillery when it could in no wise be utilized in a soap factory. Therefore it is necessary to secure the facts in relation to the quality of water supplies of a state in order that the highest industrial development may be secured.

In addition to the industrial features there are present in California peculiar conditions with reference to sources of water for domestic purposes. It has been noted in some cases that certain supplies during ordinary seasons are too hard or contain too much salt to be used with satisfaction for household purposes. Water from these same sources during times of flood is, however, of good quality. This suggests the possibility of conserving flood waters for domes-

tic use in places where it has heretofore been believed impossible to secure good supplies. This belief arose from lack of knowledge of the actual conditions. Therefore the proposed study of the seasonal variations of the quality of water in the principal streams will be of immense advantage to the many municipalities in the State of California in which it has up to this time been impossible to secure water supplies of satisfactory quality.

The investigation under the cooperative agreement will commence on or about July 1, and the greater part of the work will be performed in the laboratory of the U. S. Geological Survey at Berkeley, California.

The Sacramento Valley.

A committee appointed for the purpose by the Board of Supervisors, Red Bluff, California, has forwarded resolutions relating to the reclamation of lands in Sacramento Valley to Consulting Engineer J. B. Lippincott, of the Reclamation Service, at Los Angeles, California.

The committee believes that the construction and completion of proper dams and reservoirs upon the Sacramento River at points above Red Bluff, and upon other streams, tributary thereto, would improve the navigability of the river, and in connection with ditches to be built for irrigation purposes, would result in making far more productive a large portion of the lands in that part of the state, and be of great permanent benefit to all lands in Sacramento Valley, and petitions the government to enter upon the construction of such works as soon as practicable. The following resolution was unanimously adopted:

"Resolved; That it is the sense of this meeting that the Sacramento Valley Development Association make a strong effort to interest the entire Sacramento Valley in the irrigation of the semi-arid section thereof, also in the reclamation of the flooded districts thereof; that meetings be called and arranged for throughout the entire district interested, and such meetings reported back to the Development As-

sociation, to the end that concerted action may be taken for the earnest presentation of the matter to the U. S. Government at an early day."

Since 1895 the Hydrographic Branch of the Geological Survey has kept daily records of the flow of the Sacramento River, and the data obtained by observations of the available water supply, extending through a term of years, is of great value to any scheme of reclamation. Detailed studies are being made of the various streams of Sacramento Valley, reservoir sites are being surveyed and gaging stations established.

About four years ago the Reclamation Service, through the Water and Forest Association, expressed itself as anxious to take up a comprehensive study of the entire situation. The state cooperated in this movement, and detailed surveys of the entire floor of the Sacramento Valley have been made, as well as careful studies of the forestry conditions in its drainage basin, it being well understood that these conditions vitally affect the character of the low water and flood discharge in the streams. Extended studies of the engineering features of the proposition have also been made.

Sacramento Valley offers one of the most extensive and intricate problems in development in arid America, and the progress of the investigations is being carefully watched by the Board of Consulting Engineers. It is probable that special acts of Congress will be required for an adequate handling of the situation, both in relation to navigation and overflow, and possibly of state cooperation.

Owing to the magnitude of the problem and the numerous and heavy demands upon the resources of the Reclamation Service, it will be impossible to work out this scheme in a hurried manner. It is believed that if the organization of the committee is continued and the people prepared to cooperate with the government when the time for action arrives, one by one the various units of the enterprise will be worked out, till this greatest problem of the arid country

shall have been solved in a harmonious manner and according to a preconceived plan.

Personal Notes.

Mr. W. S. Coulter, of Boston, was recently appointed assistant engineer in the Reclamation Service, and has gone to Fort Laramie, Wyoming, where he will report to Mr. John E. Field, engineer in charge of the North Platte project.

Walter C. Wilson was recently appointed an engineering aid, and has gone to Minidoka, Idaho, to report to F. C. Horn, constructing engineer. Mr. Wilson, who is a native of Indiana and attended Earlham College, at Richmond, that State, is a graduate student of Sheffield Scientific School, Yale University. He has been engaged in surveying for the Pennsylvania Railroad Company, and as draftsman for the Louisiana Purchase Exposition.

H. M. Morse, engineering aid in Reclamation Service, has been transferred to Montana, where he will be engaged upon hydrographic work on the Milk River project under the supervision of Mr. C. C. Babb. Mr. Morse graduated from Dartmouth College with the degree of B. S., and from the Thayer School of Civil Engineering, C. E. He has served in the capacity of assistant engineer on the water works at Needham, Falmouth, and Lexington, Mass.

In the plans of the United States Geological Survey for the coming year, Mr. N. H. Darton, Chief of the Bureau of Western Hydrology, is arranging to make a thorough investigation of the artesian water supply in the region around Great Falls.

In connection with the work of the Milk River project the following assignments have been made to Mr. Cyrus C. Babb, engineer in charge; L. E. Grandke, engineer; A. H. Perkins, engineer; C. T. Prall, assistant engineer; L. R. Stockman, assistant engineer; Arthur T. Nelson, civil engineer; Joseph B. S. McIntosh, assistant engineer; M. A. Woodell, stenographic field assistant; E. J. Fisher, engineering aid; J. S. Bingham, engineering aid; J. H. Sloan, engineering aid; H. M. Morse, engineering aid; A. M. Grain, engineering aid.

Mr. George A. Hammond, superintendent of diamond drilling, U. S. Reclamation Service, has been directed to make plans for boring for foundation at Gore Canyon, in Colorado, at what is known as the Kremmling reservoir site.

Ben F. Dupuy, has been appointed engineering aid and ordered to report to Supervising Engineer L. H. Taylor, Hazen, Nevada, for work in connection with the Truckee-Carson project. Mr. Dupuy is a graduate of the Ohio State University with the degree of C. E., and has had considerable experience, especially in connection with railroads.

The Secretary of the Interior has executed the contract and approved the bond of T. P'Keefe & Company, of Oklahoma City, Oklahoma, for the erection of an eight-room school house in the city of Hobart, Oklahoma.

The Stevens-Sweetman Mercantile Company, Mondak, Montana, has been awarded the contract for furnishing the material for building required under the Fort Buford project, their bid, \$2,126.89, being the lowest.



THE NEW MONTANA

Tremendous Agricultural Development Possible
By Means of Government Reclamation Work

MONTANA'S contributions to the wealth of the nation have come mainly from the hearts of her mountains or the sands of her countless streams. While these storehouses of riches show little sign of exhaustion, a greater resource, and one which will in future yield even larger values, is just beginning to be developed. This resource is a soil so deep, black, and fertile that industrious husbandry can never exhaust its productivity. Senator Paris Gibson, an authority on agriculture, who for thirty years has studied the resources of his State, says: "Montana has potentialities in agriculture awaiting the scientific farmer which are destined, when developed, to place the State in the forefront as a producer of farm products."

With its vast area, its varied topography, its countless streams which head in regions of everlasting snow, or spring full grown from the largest glaciers in the world, its sheltered valleys and broad level mesas, Montana offers the most alluring field to which the engineers of the Reclamation Service have given their attention.

Deep in the hearts of its mountains the miner's pick is breaking down the precious metals which contribute millions annually to the world's wealth. In the solitudes of its vast forests the woodman's axe is hewing down the giant timbers, and now the silence of centuries is being broken in the desert and desolate valleys are soon to become the centers of populous and prosperous communities.

The man with the plow follows the ditch engineer, and ere the mind can grasp the thought the desert begins to fade and green fields and blossoming orchards spring into view.

Irrigation has its limits, but they are not yet apparent in Montana. While in most of the arid inter-moun-

tain States the limits of irrigation mark the limits of agricultural development, in Montana this is not true, for agriculture in many sections of that State does not depend upon irrigation. In fact, the largest yields of wheat, oats, and rye are produced on unirrigated land. Senator Gibson's ranch affords a most striking illustration of what can be done in parts of Montana without irrigation. This ranch is situated only a few miles from Great Falls, and is in a section which the Land Office was very loath to regard as anything but desert and worthless, yet the Senator secures 40 bushels of wheat per acre, 5 tons of alfalfa, and 60 bushels of heavy oats, and he has no ditches or artificial water supply. Yields of 60 bushels of wheat and 105 bushels of oats per acre are reported from adjoining ranches.

Montana's claims to recognition as one of the future great farming States are easily shown when comparisons are made between its average yields of various products and those of well known agricultural States. The Department of Agriculture furnishes the following table:

State.	Wheat. Bu.	Rye. Bu.	Bar- ley. Bu.	Oats. Bu.	Hay. Tons.	Pota- toes. Bu.	Flax. Bu.
Montana....	28	24	40	46	2.08	176	14
Iowa.....	12	16	23	24	1.78	56	10
Missouri....	8	12	18	22	1.57	66	6
Kansas.....	14	16	31	26	1.58	58	6
The Dakotas..	13	18	26	33	1.31	86	9
Minnesota...	12	18	25	32	1.84	64	9
New York...	17	15	26	34	1.26	89	..
Michigan....	15	15	25	30	1.37	78	..
Nebraska....	15	14	26	29	1.68	64	10
Wisconsin...	15	16	27	32	1.89	58	12
Pennsylvania	15	15	21	28	1.27	91	..
United States	12.3	15	26	28	1.54	84	8

In average yields of wheat, rye, barley and flax, Montana leads every State in the Union; in oats and potatoes, only one State is ahead of it, and in hay the yields are heavier than those of any Eastern State. The aver-

age wheat and potato yields are 28 and 176 bushels per acre, respectively, or more than double the average for the United States. As a matter of fact, many Montana farms run 40 and 50 bushels of wheat and 350 and 400 bushels of potatoes to the acre.

When Senator Gibson first moved into Montana agriculture was unheard of, nor was it ever thought there could be such a thing in that country. Last year Cascade county in which he resides, took the prize at the State Agricultural Fair with an exhibit which might have won the prize if it had been in competition with the entire United States. The State Fair at Helena last year contained one of the most wonderful and varied exhibits of grains, forage crops, vegetables, and fruits which has been witnessed in any State.

The agricultural resources of Montana have hardly been prospected, and the magnificent showing made at the county and State expositions is but an earnest of what is to follow. The vast bench lands of the State aggregate millions of acres, with soil of inky blackness, the grist of the mountains, capable of producing great crops. Irrigation carried on by private enterprise has brought under a high state of cultivation more than a million acres. The 10,000 farmers in the State who are artificially watering their crops have invested nearly \$6,000,000 in ditches traversing nearly 9,000 miles of desert.

The National Government, working under the provisions of the Reclamation Act of June 17, 1902, has already projected a plan of reclamation in the State which, in the near future, promises to bring under intensive cultivation an area of desert almost equal to the present irrigated acreage.

MONTANA'S WATER SUPPLY.

The great rivers of the Northwest which make up the flow of the Missouri and the Columbia come out of the Rocky Mountains in this State, and furnish a water supply sufficient for an empire. The Government engi-

neers are working on big irrigation schemes on the Milk River, Yellowstone, the Sun, Marias, Madison, and other streams, the completion of which will add tens of millions of dollars annually to the value of farm products of the State. Four of these projects are already decided upon, and will cost between five and six million dollars.

SUN RIVER PROJECT.

One of the most promising of these which Senator Gibson has been working to further, is on the Sun River, an important tributary of the Missouri, which empties into that river at Great Falls. Flowing out of steep canyons cut deeply into the main chain of the Rockies, where grey granite and white limestone pierce the clouds, and eastward from the continental divide, the Sun River rushes downward, a crystal icy torrent, leaping over precipitous heights and surging through narrow and impassable gorges, to join the Missouri.

Uncle Sam's engineers propose to bridle and harness this wild stream and make it do plebian duty on the agricultural plains and valleys which it crosses. Three hundred thousand acres with fertile desert loam await only the touch of the waters of this stream to spring into green, instinct with life and productiveness. At one point in its course, where this river cuts deep through the heart of the mountains, it dashes through a narrow gorge, a mere slit with walls a thousand feet high and but four feet apart at the bottom. Here it is proposed to erect a diversion dam which will be 125 feet high, 4 feet wide at the base, and only 15 feet wide on top. The water held in check by this dam will be diverted through a tunnel 500 feet or more in length, piercing the hard limestone and connecting with a distributory system which will carry it out upon a compact of land miles and miles in extent.

A COW PUNCHER ENGINEER.

The genius of this scheme is Samuel B. Robbins, a swarthy giant, engineer

of the U. S. Reclamation Service, six feet two in his stockings, a graduate of Yale, but for 18 years interested in Montana. He is well equipped by long experience in actual construction in this country to direct the work necessary to subdue the forces of nature found in the Sun River project. With a wiry cayuse pony under him, trained by experience to the usages of the plains, Sam Robbins is independent of railways. For the past decade the Sun River irrigation project has been his hobby, his day dream, but not until the Government came into the field was there a possibility of carrying it to completion.

POSSIBILITIES OF SUN RIVER VALLEY.

Basing the capacity of the Sun Riv-

er lands upon the average census farm returns for Montana, the Sun River Valley, when reclaimed, should yield of rough crops nearly 10,000,000 bushels of wheat, or 600,000 tons of alfalfa, worth this year in Great Falls \$15 a ton.

The production of vegetables, sugar beets, or fruit, will be immense. Once brought under a perfect system of irrigation as the one the Government proposes, this valley will support a prosperous farm population of 15,000 and make a splendid city of Great Falls, whose marvelous manufacturing possibilities in the shape of 340,000 latent horse power racing down the falls of the Missouri are already attracting attention.

A SUGGESTION REGARDING THE NATIONAL FOREST RESERVES

Editor of FORESTRY AND IRRIGATION:

Dear Sir:

THE recent transfer of the administration of the national forest reserves from the General Land Office to the Bureau of Forestry opens such broad and varied opportunities for forest work, that we are inclined already to look into the future and picture to ourselves some of the important changes that are destined to take place within those areas. We may naturally expect to see the principles of silviculture and general protective and economic forestry applied more extensively and effectively than heretofore, while the history of the Bureau gives assurance that local interests and practical ideas will receive every consideration in the management of the reserves. In thinking over the future development thus promised by the service of the Bureau, I have been impressed especially with the intricacy of the silvicultural conditions. It has occurred to me in this

connection that certain areas within the reserves might be utilized in a special way to simplify silvicultural problems. Believing that the suggestion which I have to make may possibly be of interest to readers of this magazine, I will, with your permission, outline it in the following paragraph:

Whoever has studied the artificial forests of Germany, France, and other European countries in which systems of forestry have become firmly established, must have noticed the restrictions there placed upon the free play of nature's forces and the consequent loss in suggestiveness to the student of forest life. Where trees are commanded to live in mixture or separated according to species, to grow densely or openly, to disappear at a certain age; where, also, undergrowth and surface-growth are encouraged or excluded, as the case may be, and even the nature of the soil is gradually brought into subjection, the language of the forest becomes less and less varied in its expression. But where nature is al-

lowed perfect freedom an endless variety of idioms, so **to speak, is** found, and, by the same analogy, changing moods and tenses give expression to the character of the forest and reveal its capabilities.

It is true that the artificial forest sometimes teaches us silvical truths that are hidden or unobservable in the natural forest. It is also true that in our own forests, where the accidents of civilization have often interfered rudely and suddenly with a natural development, new and valuable information is sometimes presented in the most emphatic and striking manner. But such lessons have a restricted meaning when compared with the subtle teachings of the purely virgin forest, because they are based on sudden and drastic changes, which interfere with the operation of other forces and which it is often undesirable or impossible to repeat in practice. On the other hand, the life history of the virgin forest is more logical and connected and, although in many things inscrutable and difficult of interpretation, it yields the richest suggestions to careful investigation.

Such considerations have made it appear to me that it might be of much practical value in the development of future systems of forest management, if selected areas of purely virgin forest could be maintained in that condition for purposes of study and comparison. These would, in addition, be of general scientific and historic interest and would be most welcome to students of nature, as well as to lovers of landscape and to all those who appreciate the quiet, wild places of the earth.

It may possibly be objected that we already possess extensive reserves of this kind in our national parks; but the purpose of these is entirely different. Most of the national parks were established to preserve some natural wonder of geologic or botanic interest, or to commemorate some important event in our national history. They do not illustrate with any completeness

the striking relations between forest growth and geologic formation, altitude, latitude, rainfall, and other geographic and climatic factors. Or it may be thought that the selection of truly representative areas for different regions would be difficult, if not impossible, on account of the rare occurrence of purely virgin tracts, entirely unchanged by fire, grazing, or other human interferences. To this it may be answered that absolutely primitive conditions would hardly be necessary; it would be sufficient for practical purposes if the reserved areas clearly represented distinct types of forest and a reasonably close approximation to virgin conditions. By carefully protecting such areas they might soon be led back to a perfectly natural state.

It is not my purpose to enter into details here regarding the necessary number or the proper sizes of these local or regional forest type reservations, but it is evident that they should be so chosen and delimited as to constitute in each case an individual and unified whole; as, for example, a distinct section of some valley, a minor watershed, or a small basin. They should also be so situated as to lend themselves to some practical, efficient system of protection.

If there is practical value in the foregoing suggestion it would seem desirable to make an early segregation of such tracts; not because there is an immediate necessity for them, but because propositions of this nature, if they do not receive early attention, are less likely to be considered in the urgency of later work.

Let me call attention to the æsthetic value that would belong to such reservations and the interest that they would have for future generations as examples of the genuine, unaltered expressions of nature. In them might be preserved the expressive forms of many kinds of trees, the manifold beauties of foliage and branches, the characteristic groupings in the natural forest, and its peculiar lights and shadows. Large old trees, striking

rock forms, and geologic features of unusual interest might in them find a proper setting. Here also might be found the subtle influence that nature has on our moral and physical well-being, the quality of wild places that appeals to many of us in such a strange, intimate way.

I should not like to convey the impression of believing all merely natural scenes and objects to be on that account necessarily beautiful, although nature contains so much beauty, not only in detail but even in combination. Neither does it seem to me that the operations of forestry generally result in producing æsthetic effects in the forest. Incidentally, although almost always unintentionally, certain new forms of beauty may be thus produced. On the whole the forests become stereotyped. Often it is the mere technical excellence of the artificial forest that makes it appear attractive in the eyes of the professional forester.

Our national forest reserves are still to a large extent in a wild, natural state, and it will be many years, in fact, before they shall have become impressed with the stamp of artificiality. Fire-scarred and over-grazed as many of them are, careful treatment can but improve the appearance which large areas in the reserves present to-day. And yet there are corners and ridges and valleys in these reserves that would retain a higher

scenic value by being left untouched, if such a sacrifice were possible. Would it not be possible to combine in each of the proposed special reservations the silvicultural aims and the æsthetic ones?

Many people are deeply interested in the national forest reserves for other reasons than the material benefits which they will bring. There is, in fact, a very wide popular interest in nature for its own sake. This is shown not only by the decided increase of literature that deals with nature-study in its various forms, but by the tendency to live out of doors and to travel, by the increase of suburban and country homes, the formation of outdoor art associations and the rapid extension and development of public parks. Considering these things, and realizing also that by far the larger part of the forested areas of the United States are held by individuals and corporations, and that private owners cannot be expected to relinquish any part of their holdings for special purposes from which they can derive no tangible benefit, the question arises: cannot the government reserve certain selected areas, insignificant in their combined extent, for the purposes that have been indicated and as an uplifting influence for those that may come after us?

Very sincerely yours,

G. FREDERICK SCHWARZ.



WATER PROBLEMS OF SANTA BARBARA

A REPORT called "Water Problems of Santa Barbara, California," by Mr. J. B. Lippincott, which the United States Geological Survey has recently published, will be interesting to the many people who have found that the city and suburbs of Santa Barbara constitute one of the most attractive and most productive districts of that favored State. The locality is disappointing only in not possessing an adequate water supply.

In response to a request from the city and county of Santa Barbara, the United States Geological Survey has recently made topographic surveys that cover the entire district, and has investigated the water problems of the area. Maps of the Goleta, Santa Barbara, Santa Ynez, and Mount Pinos quadrangles have been published. The Santa Maria quadrangle has also been surveyed, and a map of it is now in the engravers' hands. In the hydrographic investigations the city of Santa Barbara has coöperated, paying one-half of the expense connected with the maintenance of gaging stations on Santa Ynez River and Mono Creek. On these streams daily observations have been made for silt, volume of flow, and mineral impurities of the water.

The district under investigation extends from Ventura River, in Ventura County, along the coast as far as Goleta, in Santa Barbara county, and more particularly into the high, mountainous districts of Ventura and Santa Barbara counties lying on the north side of the Santa Ynez Range and including the drainage basin of Santa Ynez River and its tributaries. The coastal plain fronting the ocean consists of a series of old marine beaches and undulating foothills facing Santa Barbara Channel. The Santa Ynez

Mountains run parallel to the coast, rising to elevations ranging from 3,000 to 4,000 feet and presenting a bold and attractive background to the foothill districts. A second range of mountains, consisting of the crest of the Coast Range and culminating in Mount Pinos, the elevation of which is 8,826 feet, lies farther north and trends parallel to the Santa Ynez Mountains, extending westward, parallel to the coast. It has a total length of about 70 miles, with flat grades, and offers frequent opportunities for impounding water in storage reservoirs.

Mr. Lippincott reviews the reports made by various distinguished engineers who have investigated the hydrography of the Santa Barbara and finds that all of them agree on the following vital points: (1) That the present supply of water for the city of Santa Barbara is inadequate and that unless it is increased the material development of the town will be seriously impeded; (2) That there is no adequate water supply within a reasonable limit of the city of Santa Barbara on the south side of the range, and even if the water of such small streams as are there could be obtained it would be at a sacrifice of existing development; (3) That it is feasible and desirable to obtain an adequate supply of water from the drainage basin of Santa Ynez River, and that this can be done at a profit.

Mr. Lippincott carries the investigation farther and concludes: (1) That the only extensive addition that can be made to the water supply of the Santa Barbara coastal plain is by the construction of a tunnel from Santa Ynez River to the coast side of the mountains and the erection of an impounding reservoir for holding the winter flood waters of Santa Ynez River; (2) That by far the most desir-

able point on Santa Ynez River for this construction is the Gibraltar reservoir site; (3) That the water can be delivered at a reasonable cost for both

irrigation and domestic use to Santa Barbara and vicinity from this site. Mr. Lippincott estimates in detail the cost of the work.

STREAM MEASUREMENTS IN THE UNITED STATES

THE sundry civil bill for 1906, passed by the last Congress contains an item of \$200,000 appropriated to the United States Geological Survey for the purpose of gaging streams and determining water supply. With this sum it is proposed to continue the work of measuring streams in all parts of the United States and of collecting data that will be helpful in promoting water powers and irrigation projects, and valuable in determining the quality of water best suited for domestic and municipal purposes and for manufacturing enterprises.

Estimates of the daily flow of important rivers are needed by engineers and investors, as is shown by the many requests for such information received from all parts of the country. It is believed that more than \$5,000,000 is annually expended in new projects that are stimulated largely by facts that have been ascertained officially during years of careful observation.

The water powers of New England have reached a high state of development, but many resources are not yet utilized—particularly those in Maine. There is constant demand for official data, and investigation will therefore be made of the character of certain New England waters with reference to their use for manufacturing purposes. Studies will also be made of the pollution of waters in this region from natural or artificial sources.

From New York southward in the Appalachian region a very extraordinary development of water powers is taking place, particularly in connection with cotton manufacture and electrical transmission. In some cases industrial investment is now awaiting the acquisition of definite information concerning the character of the waters.

From Ohio westward through the central Mississippi Valley, where the streams are relatively sluggish, water power is of less immediate importance than in the Eastern States, but here questions of adequate supplies of water suitable for manufacturing and industrial purposes are pressing. Plans are being made for the definite ascertainment of facts concerning the quantity and quality of supplies available from rivers and underground sources. When these facts are determined it will be possible to answer intelligently the numerous inquiries made as to the character of these supplies and their protection from manufacturing waste, sewage, and other destructive influences. Widespread information regarding the geology, topography, and water supply of the country should lead to great advances in manufacturing.

In the west the reclamation fund is available for the construction of irrigation works by the Government. At the same time the area available for agriculture will be largely increased by the construction of small irrigation systems. It is proposed to continue the measurement of streams in all the western states, in order to obtain data upon which to base investment of private or corporate capital, and to put on record information which can be obtained only by the Government, such as the measurements of interstate streams.

In short, it is proposed to continue, in nearly every state in the Union, the collection of facts concerning the surface and underground waters—their quantity, quality, and the influences which make them valuable or which destroy their usefulness for industrial purposes.

DEPARTMENT OF THE INTERIOR, United States Geological Survey, Reclamation Service, Washington, D. C., April 29, 1905. Sealed proposals will be received at the office of the Engineer, U. S. Reclamation Service, Billings, Mont., until 2 o'clock p. m., June 28, 1905, and thereafter opened, for the construction of about 30 miles of canal, involving about 700,000 cubic yards of earthwork, some rock work and three tunnels, the same being a portion of a system for the diversion of about 400 cubic feet of water per second from the Yellowstone River at a point about ten miles east of Billings, and its conveyance to irrigable lands along the south side of said river. Specifications, forms of proposal, and plans may be obtained at the office of the Chief Engineer, U. S. Reclamation Service, Washington, D. C., or from R. S. Stockton, Engineer, Billings, Mont. Each bid must be accompanied by a certified check for \$1,000, payable to the order of the Secretary of the Interior, as a guaranty that the bidder will, if successful, promptly execute a satisfactory contract and furnish bond as required. It must also be accompanied by the guaranty of responsible sureties to furnish bond as required, if the bid be accepted. The right is reserved to reject any or all bids, to accept one part and reject the other, and to waive technical defects, as the interests of the service may require. Bidders are invited to be present. Proposals must be marked "Proposals for the construction of canal, Huntley project, Montana." E. A. HITCHCOCK, Secretary.

DEPARTMENT OF THE INTERIOR, United States Geological Survey, Reclamation Service, Washington, D. C., April 29, 1905. Sealed proposals will be received at the office of the Engineer, United States Reclamation Service, Billings, Montana, until 2 o'clock p. m., June 28, 1905, and thereafter opened, for the construction of pumping station, concrete culverts, siphons, drops, etc., and furnishing two steel highway bridges, four steel sluice gates with stands, and 120,000 pounds steel bars for reinforcing concrete. Total amount of concrete about 1,600 cubic yards. Above work to be done along line of canal east from Huntley, Montana, in connection with the Huntley project. Specifications, form of proposal, and plans may be obtained at the office of the Chief Engineer of the Reclamation Service, Washington, D. C., or from R. S. Stockton, Engineer, Billings, Montana. Each bid must be accompanied by a certified check for \$1,000, payable to the order of the Secretary of the Interior, as a guaranty that the bidder will, if successful, promptly execute a satisfactory contract and furnish bond in the sum of \$10,000 for the faithful performance of the work. It must also be accompanied by the guaranty of responsible sureties to furnish bond as required if the bid be accepted. The right is reserved to reject any or all bids, to accept one part and reject the other, and to waive technical defects, as the interests of the service may require. Bidders are invited to be present. Proposals must be marked "Proposal for building structures and furnishing material, Huntley project, Montana." E. A. HITCHCOCK, Secretary.

DEPARTMENT OF THE INTERIOR, United States Geological Survey, Reclamation Service, Washington, D. C., June 9, 1905. Sealed proposals will be received at the office of the Supervising Engineer, United States Reclamation Service, 1108 Braly Building, Los Angeles, California, until 2 o'clock p. m., August 17, 1905, and thereafter opened, for the construction of about 12 miles of dike, involving excavation of about 445,000 cubic yards of earth, and clearing 125 acres, for the reclamation of Yuma Valley, Arizona. Specifications, forms of proposals and plans may be obtained from the Chief Engineer of the Reclamation Service, U. S. Geological Survey, Washington, D. C., from the Supervising Engineer, Los Angeles, California, and from the Engineer of the Reclamation Service, Yuma, Arizona. Each bid must be accompanied by a certified check for three (3) per cent. of the amount of the bid, payable to the order of the Secretary of the Interior, as a guaranty that the bidder will, if successful, promptly execute a satisfactory contract, and furnish bond in the sum of 20 per cent. of the contract price for the faithful performance of the work. It must also be accompanied by the guaranty of responsible sureties to furnish bond as required, if the bid be accepted. The right is reserved to reject any or all bids, to accept one part and reject the other, and to waive technical defects, as the interests of the Service may require. Bidders are invited to be present. Proposals must be marked; "Proposals for the construction of dikes, Yuma project." E. A. HITCHCOCK, Secretary.

DEPARTMENT OF THE INTERIOR, United States Geological Survey, Reclamation Service, Washington, D. C., May 23, 1905. Sealed proposals will be received at the office of the Engineer U. S. Reclamation Service, Belle Fourche, S. Dak., until 2 o'clock p. m., Monday, June 26, 1905, and thereafter opened, for the construction and completion of a telephone system, about 16 miles in length and having 4 telephone stations, in connection with the Belle Fourche project, near Belle Fourche, S. Dak. Specifications, forms of proposals, and particulars may be obtained from the Chief Engineer of the Reclamation Service, U. S. Geological Survey, Washington D. C., or the Engineer in charge of the Belle Fourche project, Belle Fourche, S. Dak. Each bid must be accompanied by a certified check for 2 per cent. of the contract price, payable to the order of the Secretary of the Interior, as a guaranty that the bidder will, if successful, promptly execute a satisfactory contract and furnish bond in the sum of 20 per cent. of the contract price for the faithful performance of the work. The right is reserved to reject any or all bids, to accept one part and reject the other, and to waive technical defects as the interests of the service may require. Proposals must be marked "Proposals for telephone system, Belle Fourche project, S. Dak." E. A. HITCHCOCK, Secretary.

A Liking for the Open Road

Goes with a Taste for Apples
and Schubert's Music

THE OPEN ROAD

A SAUNTERER'S CHRONICLE

EDITED BY CHARLES WISNER BARRELL
(Sometime of Vagabondia)

Is a de luxe pocket magazine of
outdoor philosophy and fiction

If you ever long for a whiff of unbreathed
literary ozone, send *Fifty Cents* without delay
for a year's subscription to

The Open Road

137 GRANT AVENUE

Jersey City

New Jersey

GREEN

Principles of American Forestry

12mo, xiii X 334 pages, 73 figures, in-
cluding many half-tones. Cloth, \$1.50

WILSON

Irrigation Engineering

Fourth edition, enlarged and rewritten.
Small 8vo, xxiii X 573 pages, 41 full page
plates, mostly half-tones, and 142 figures.
Cloth, \$4.00

SNOW

The Principal Species of Wood: Their Characteristic Properties

Large 8vo, xi X 203 pages, figures in the
text, 39 full page half-tones. Cloth, \$3.50

ELLIOTT

Practical Farm Drainage

12mo, 100 pages, 25 figures. Cloth, \$1.00

ELLIOTT.

Engineering for Land Drainage

12mo, vii X 232 pages, 41 figures, 6 full
page half-tones. Cloth, \$1.50

JOHN WILEY & SONS

43 and 45 East 19th St New York City

Foresters and Botanists will find profit and
pleasure in

Important Philippine Goods

The standard reference book for Philippine
forests. By Capt. G. P. AHERN, Chief of Philip-
pine Forestry Bureau. 42 large colored plates.
Price, \$3.00.

Forestry and Irrigation Book Dept.

"Land Scrip."

Safe, quick, economical method of
acquiring Government land.

Hugo L. Seaberg,

Raton, N. Mex.

LAUGHLIN

FOUNTAIN PEN

The Best at Any Price

Sent on approval to
responsible people.

A Pocket Companion of
never ending usefulness, a
source of constant pleasure
and comfort.

To test the merits of
Forestry and Irrigation
as an advertising medium
we offer your choice of
these popular styles super-
ior to the

\$3.00

grades of other makes for
only

\$1.00

Unconditionally Guaranteed
Pre-eminently Satisfactory.

Try it a week, if not suited,
we buy it back, and give you
\$1.10 for it (the additional ten
cents is to pay for your trouble
in returning the pen). We are
willing to take chances on you
wanting to sell; we know pen
values—you will when you
have one of these.

Finest quality hard Para rubber
reservoir holder, 14k. Dia-
mond Point Gold Pen, any
desired flexibility in fine, med-
ium or stub, and the only per-
fect ink feed known to the ac-
cendence of fountain pen making.
Sent postpaid on receipt of \$1.00
(Registration, 50 cents.)

This great Special Offer is
good for just 30 days. One of
our Safety Pocket Pen Holders
free of charge with each
pen.

Remember—There is No
"just as good" as the Laugh-
lin; insist on it; take no
chances.

State whether Ladies' or
Gentlemen's style is desired.
Illustrations are full size of
complete article. Address

LAUGHLIN & CO.,

841 Griswold St

Detroit, Mich

BOOKS FOR BUSINESS MEN

TERMS cash with order. We make no deviation from this rule. Prices unless otherwise stated, include transportation.

The Business World Company, 1 Madison Avenue, New York City

IMPORTATIONS

ACCOUNTANCY PUBLICATIONS

The prices quoted include both duty and postage.

Accountants' Accounts. By William Henry Fox. Price \$3.00

Accountants' Assistant, The. An Index to Various Lectures of English and Scottish Accountants, Articles, etc. Price \$2.50.

Accountants' and Bookkeepers' Vade-Mecum, The. By G. E. Stuart Whatley. Price \$3.00.

Accountants' Compendium. By S. S. Dawson, A. C. A. A complete Lexicon on Accountancy subjects. 400 pages. Price \$6.00.

Accounting in Theory and Practice. By George Lisle, C. A., F. F. A. Price \$5.50.

Deals with the principles of general accounting, and is an exhaustive work on the subject.

Accountants' Library, The. A series of handbooks, which, when completed, will comprise systems of bookkeeping adaptable to all classes of business enterprises. The authors of the various books know the subject they write about thoroughly and their readers can rest assured that the information they obtain from this valuable series is authentic and practical

Advanced Accounting. By Lawrence R. Dicksee, F. C. A. 400 pages. Price \$8.40.

Auditing. A practical Manual for Auditors. Fifth edition. 800 pages. By Lawrence R. Dicksee, F. C. A. Price \$8.40.

Auditors: Their Duties and Responsibilities under the Joint Stock Companies Acts, and the Building Associations, Friendly Societies, and Industrial Societies Acts (English). By Francis W. Pixley. Price \$7.50. Postage and packing, 15 cents extra.

Balancing for Expert Bookkeepers. By G. P. Norton. Price \$2.40.

Bookkeeping for Accountant Students. By Lawrence R. Dicksee, F. C. A. Price \$4.20.

Bookkeeping for Company Secretary. By Lawrence R. Dicksee, F. C. A. Price \$1.40.

Bookkeeping Exercises for Accountant Students. By L. R. Dicksee. Price \$1.40.

Bookkeeping for Retail Traders. By Findlay. Price \$1.20.

Bookkeeping for Solicitors. By Hodsoll. Price \$1.40.
A new system.

Bookkeeping for Terminating Building Societies. By J. F. Lees. Price \$1.40.

Brewers' Accounts. By William Harris. 130 pages. Cloth. Price \$2.50.

Canadian Accountant, The. By S. G. Beatty and J. Johnson, F. C. A. Price \$2.00.

Company Secretary, The. By W. H. Fox, C. A. 400 pages. Price (new edition) \$10.00.

Cost Accounts of an Engineer and Iron Founder. By J. W. Best, F. C. A. Price \$1.00.

Encyclopedia of Accounting. Edited by George Lisle, C. A., author of "Accounting in Theory and Practice." With contributions by Lawrence R. Dicksee, F. C. A., Francis W. Pixley, F. C. A., Gerard Van de Linde, F. C. A., and Arthur F. Whinney, F. C. A. Six volumes. Price \$8.00 per volume; complete set, \$48.00.

Engineering Estimates, Costs and Accounts. By a General Manager. Price \$4.80.

Executorship Accounts. With a complete set of accounts. By F. Whinney. Price \$3.00.

Factory Accounts. By Garcke and Fells. (Fifth edition.) Price \$3.00.

CATALOGUE SENT FREE

EVERY BUSINESS MAN should read **THE BUSINESS WORLD** published monthly. It's full of hints and valuable suggestions. 10 cents a copy; \$1 a year. Send for sample copy.

THE BUSINESS WORLD COMPANY,
1 MADISON AVENUE, NEW YORK CITY

AMERICAN WOODS

By Romeyn B. Hough, B. A.

A publication unique in its illustrations, in that they are actual specimens instead of pictures, giving literally "sermons in trees"



A VOLUME OF THE "AMERICAN WOODS" DISPLAYED

EACH page contains three paper-thin sections of actual wood—transverse, radial, and tangential—and as these are nearly transparent, they show clearly the structure. They are mounted on strong bristol board, which bears the accurate scientific and popular names of each specimen shown, together with the common name in German, French, and Spanish.

Invaluable for
**BOTANISTS
WOODWORKERS
LUMBERMEN
FORESTERS
ARCHITECTS
BUILDERS**

The pages on which the specimens of wood are mounted are separate, to facilitate examination and comparison one with another, and in order that they may be used in direct connection with the text which accompanies each volume.

Of great use to
**SCHOOLS
COLLEGES
MUSEUMS
LIBRARIES and
PRIVATE
COLLECTIONS**

Ten parts of this great work have been issued and are ready for delivery; others will follow at the rate of one or two parts per year. Each part contains at least three specimens each of 25 species, with illustrated text.

The following are the net prices per part:

Green or brown cloth, imitation morocco, \$5.00. Half-morocco, \$7.50

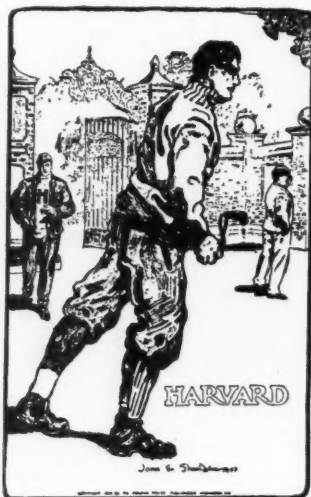
Address: **FORESTRY AND IRRIGATION**

510 Twelfth Street, N. W., Washington, D. C.

In writing advertisers kindly mention FORESTRY AND IRRIGATION

College Posters

In the colors of the college they represent; size 14 x 22 inches. They are to the athletic world what the Gibson and Christy pictures are to the social world.



Price 25 Cents; or any Five for \$1

Post paid, on receipt of price. Write for catalogue containing miniature sketches like the above.

H. M. Suter Publishing Co.

509 12th STREET, N. W.

WASHINGTON, D. C.

The American Sportsman's Library

Under General Editorship of CASPAR WHITNEY

*The only Library of Sports Adapted to the American Reader
Complete in 20 volumes, at \$2 net per volume*

A partial list of Contributors includes

Theodore Roosevelt, Dean Sage, Edwyn Sandys, Charles F. Holder, F. S. Van Dyke, L. C. Sanford, James A. Henshall, Owen Wister.

The volumes are illustrated by such artists as

A. B. Frost, Carl Rungius, L. A. Fuertes, Charles L. Bull, Martin Justice, C. F. W. Mielatz, and Tappan Adney.

Published in two series of 10 volumes each, all uniform, the whole set is a remarkable epitome of outdoor life, dealt with authoritatively, yet in simple and untechnical language, and in each volume will be found much to interest and instruct the general reader

Of the First Series, those now ready are:

The Deer Family

By Theodore Roosevelt and others. Illustrated by Carl Rungius, with maps by Dr. C. Hart Merriam.

Salmon and Trout

By Dean Sage, W. C. Harris, and H. C. Townsend. Illustrated by A. B. Frost and others.

Upland Game Birds

By Edwyn Sandys and T. S. Van Dyke. Illustrated by L. A. Fuertes, A. B. Frost, C. L. Bull and others.

The Water-Fowl Family

By L. C. Sanford, L. B. Bishop and T. S. Van Dyke, illustrated by A. B. Frost, L. A. Fuertes, and C. L. Bull.

Bass, Pike, Perch, and Others

By James A. Henshall, M. D. Illustrated by Martin Justice and Charles F. W. Mielatz.



The Big Game Fishes of the United States

By Charles F. Holder. Illustrated by Chas. F. W. Mielatz and others.

To be ready in the Fall

The Bison, Musk Ox, Sheep and Goat Family

By George Bird Grinnell, Owen Wister, and Caspar Whitney. Illustrated by Carl Rungius and others.

Cougar, Wild Cat, Wolf and Fox

With many illustrations.

The Bear Family

By Dr. C. Hart Merriam. Illustrated by Carl Rungius and C. L. Bull.

Guns, Ammunition and Tackle

By A. W. Money and others. Illustrated,

SECOND SERIES—In Preparation

Photography for the Sportsman Naturalist, The Sporting Dog, The American Race Horse, The Running Horse, Trotting and Pacing, Riding and Driving.

Baseball, Football, Yachting, Small Boat Sailing and Canoeing, Rowing, Track Athletics, and Swimming, Lacrosse, Lawn Tennis, Boxing, Wrestling, Etc., Skating, Hockey, Ice Yachting, Coasting, Etc.

SPECIAL OFFER

This exceedingly interesting and valuable series will be offered for a limited period upon very liberal terms. Send \$4.00 with coupon cut from this magazine and \$1 per month for 36 months thereafter, and we will send you free of all charges the volumes now ready, and the others as they are issued. The books are good to look at, being tastefully bound in dark green cloth, with gold ornaments and lettering and gilt top.

The MACMILLAN COMPANY
66 FIFTH AVENUE, . . . NEW YORK

I accept your offer of THE AMERICAN SPORTSMAN'S LIBRARY in 20 volumes. Enclosed find \$4.00 for first payment, \$1.00 each month to be remitted by me for 36 months.
Name: _____
Address: _____
City: _____
State: _____

In writing advertisers kindly mention FORESTRY AND IRRIGATION.

SPECIAL ANNOUNCEMENT

An invitation is extended to any white merchant outside of New York City, or their representative, whose name appears in Bradstreet's or Dunn's Commercial Agency Book, to accept the hospitality of our Hotel for three days without charge. Usual rates, apartment with private bath \$3.00 per day and up, without meals. Parlor, Bedroom and Private Bath, \$35.00 per week and up, with meals for two. New York Merchants and Editors are requested to call the attention of their Out-of-Town Buyers and Subscribers to this advertisement.

HOTEL GALLATIN

70 W. 46th St., New York City



Anyone sending a sketch and description may quickly ascertain our opinion free whether an invention is probably patentable. Communications strictly confidential. **HANDBOOK** on Patents sent free. Oldest agency for securing patents. Patents taken through Munn & Co. receive special notice, without charge, in the

Scientific American.

A handsomely illustrated weekly. Largest circulation of any scientific journal. Terms, \$3 a year; four months, \$1. Sold by all newsdealers. **MUNN & Co.** 361 Broadway, New York
Branch Office, 625 F St., Washington, D. C.

UNION PACIFIC

KNOWN AS

"The Overland Route"

Is the most direct line to all principal points west, and offers a more diversified route to select from than any other Trans-Continental line.

Every Business Interest is to be found along its Line

FOR THE MINER

The great mountains of the West wait but the opening to become the source of large fortunes

FOR THE FARMER

Thousands of acres of rich agricultural lands are yet open for settlement

FOR THE STOCK-RAISER

Immense areas of excellent grazing lands can yet be secured

FOR THE BUSINESS MAN

The growing cities and towns of the West are daily offering unequalled opportunities for investment of capital and location of industries which are unsurpassed by older sections of the United States

Inquire of E. L. LOMAX, G. P. & T. A.,
Omaha, Nebr.

300 ACRES OF

**Hardy Ornamental Trees, Shrubs,
Evergreens, Vines and Perennials**

THOMAS MEEHAN & SONS, Inc., Dreshertown, Penn.

**Nursery Lane
Nurserymen and Tree Seedsmen.**



RAISE IRRIGATING WATER

by natural stream fall. One foot raises thirty feet. Raise any quantity for irrigation, stock, railroad tanks, town supply, etc., with

RIFE HYDRAULIC RAMS

No attention ever required, and it's always going, insuring constant supply. Runs for years without expense. Raise any height and carry any distance. Sold on 30 days free trial. Write for free book.

Rife Engine Co., 126 Liberty St., New York.

BLOCK,

Photographer

Views, Lantern Slides, Bromide Enlargements, Copying, Developing and Printing

**215 SIXTH STREET, S. E.
WASHINGTON, D. C.**

ORCHIDS

ORCHIDS

We are the largest Orchid Growers in the United States : : : : :
Our Illustrated and Descriptive Catalogue of Orchids is now ready and may be had on application.

Orchid Growers and Importers. **LAGER & HURRELL**
SUMMIT, N. J.

Read "Irrigation in the United States," by Frederick Hayes Newell, Chief Engineer U. S. Reclamation Survey. Price, \$2, postpaid to any address. Address "Forestry and Irrigation," Washington, D. C.

Construction News Press Clippings

CONTRACTORS, MATERIAL MEN, BUILDERS, MANUFACTURERS, in fact, **ANYBODY** interested in Construction News of all kinds, obtain from our daily reports **QUICK, RELIABLE INFORMATION**. Our special correspondents all over the country enable us to give our patrons the news in advance of their competitors and before it has become common property.

Let us know what you want and we will send you samples and quote you prices.

PRESS CLIPPINGS on any subject from all the leading current newspapers, magazines, trade and technical journals of the United States and Canada. **PUBLIC SPEAKERS, WRITERS, STUDENTS, CLUB WOMEN** can secure reliable data for speeches, essays, debates, etc. Special facilities for serving Trade and Class Journals, Railroads and large industrial corporations.

WE READ, through our staff of skilled readers, a more comprehensive list of publications than any other Bureau **WE AIM** to give prompt and intelligent service at the lowest price consistent with good work. Write us about it. Send stamp for booklet.

United States Press Clipping Bureau
147 Fifth Ave., Chicago, U. S. A.

The . . **PAPER** . . that this publication is printed on is furnished by

R. P. Andrews & Company (Inc.), Washington

Sole Agents in the District of Columbia for the **West Virginia Pulp and Paper Company**, the Largest Manufacturers of Book Paper in the world.

IF IN NEED, DROP THEM A LINE

In writing advertisers kindly mention **FORESTRY AND IRRIGATION**.

T H E

National

Irrigation

Association

Chicago,
1707 Fisher Building.

New York,
17 Battery Place.

Washington,
5 and 6 Glover Building.

OFFICERS.

THOS. F. WALSH, Washington,
President.

GEORGE H. MAXWELL, Chicago,
Executive Chairman.

JAMES H. ECKELS, Chicago,
Treasurer.

CHARLES B. BOOTHE, New York,
Chairman Executive Council.

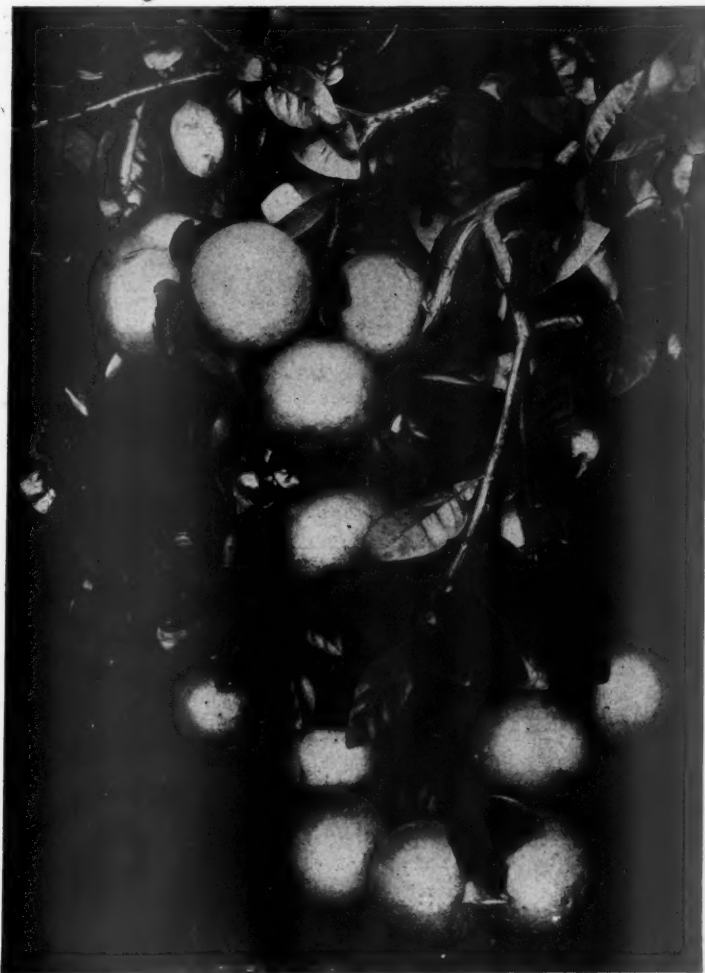
GUY E. MITCHELL, Washington,
Secretary.

The objects of the Association, as set forth in its Constitution, are as follows:

1. The adoption by the Federal Government of a permanent policy for the reclamation and settlement of the public domain, under which all the remaining public lands shall be held and administered as a trust for the benefit of the whole people of the United States, and no grants of the title to any of the public lands shall ever hereafter be made to any but actual settlers and homebuilders on the land.
2. The preservation and development of our national resources by the construction of storage reservoirs by the Federal Government for flood protection, and to save for use in aid of navigation and irrigation the flood waters which now run to waste and cause overflow and destruction.
3. The construction by the Federal Government of storage reservoirs and irrigation works wherever necessary to furnish water for the reclamation and settlement of the arid public lands.
4. The preservation of the forests and reforestation of denuded forest areas as sources of water supply, the conservation of existing supplies by approved methods of irrigation and distribution, and the increase of the water resources of the arid region by the investigation and development of underground supplies.
5. The adoption of a harmonious system of irrigation laws in all the arid and semi-arid states and territories under which the right to the use of water for irrigation shall vest in the user and become appurtenant to the land irrigated, and beneficial use be the basis and the measure and limit of the right.
6. The holding of an annual Irrigation Congress, and the dissemination by public meetings and through the press of information regarding irrigation, and the reclamation and settlement of the arid public domain, and the possibilities of better agriculture through irrigation and intensive farming, and the need for agricultural education and training, and the creation of rural homes as national safeguards, and the encouragement of rural settlement as a remedy for the social and political evils threatened by the congestion of population in large cities.

TROPICAL FORESTRY AND HORTICULTURE

Reports and working plans for estates in Southern Florida, Bahamas, Cuba, Isle of Pines, Porto Rico, and neighboring regions



The Pomelo, or Grape Fruit, the Favorite of all Breakfast Fruits, for which the southernmost part of the Peninsula of Florida is famous. For the production of this profitable fruit this region has no rival

Tropical forest lands bought and sold. Villa sites and grove land for sale in Biscayne Bay region. Write for prospectus. Address

JOHN GIFFORD, Princeton, N. J., or Coconut Grove Dade Co., Fla.

California

IRON MOUNTAIN ROUTE



TRUE
SOUTHERN
ROUTE

W. E. HOYT, G. E. P. A.
335 Broadway, New York, N. Y.

H. C. TOWNSEND, CHIEF CLERK

**Lewis and Clark Exposition
Portland, Ore.**

FROM ST. PAUL

Round Trip **\$45**

See the

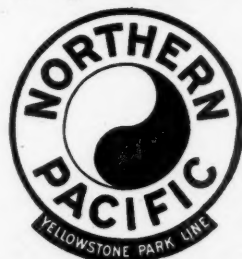
Yellowstone National Park

P. W. PUMMILL, Dist. Pass. Agent, 711 Chestnut St., Philadelphia, Pa.

Send four cents for **LEWIS AND CLARK BOOKLET** to

A. M. CLELAND, GENERAL PASSENGER AGENT, - - - ST. PAUL, MINN.

LOW RATES FROM ALL POINTS



In writing advertisers kindly mention FORESTRY AND IRRIGATION.

"YOUR PROFITS"

is the title of a folder in which we prove that no matter what your business may be, it can be increased. We not only prove that it can be increased but we tell you how, at a very slight expense, you can put yourself in a position to

Double Your Business

This folder opens a way to the solution of the one hundred and one business and advertising problems which continually confront the retailer, wholesaler, the mail order merchant, and the manufacturer. Better write for it on your letter head TO-DAY.

ADDRESS

The Clark Company

SCRANTON, PA.



The duffle for a summer camp has a great deal to do with the comfort and pleasure of an outing, but it doesn't begin to compare in importance with a good tent.

Tent making is where we started. The reputation which has given us the outfitting of polar expeditions grew from our tent-making skill.

Our WATER-PROOF CANOE TENT, made in Duck or Silk, is our newest idea for the camper.

We have every camp accessory, even to the smallest detail. Send for Catalogue I —also contains full list of fishing tackle.

ABERCROMBIE & FITCH CO.
Manufacturers of Complete Outfits for Explorers, Campers and Prospectors,
314-316 Broadway, New York, U.S.A.



The Tourist Girl

Nice Enough For Anybody.

Ladies traveling to California appreciate the delightful home comforts of our superior Tourist Pullmans.

Harvey serves the meals

Many other exclusive and distinctive features.

Ask General Passenger Office, Atchison, Topeka & Santa Fe Railway, Chicago, about very low one-way rates to California, March 1 to May 15

ESTABLISHED 1802

Thorburn's Seeds

for over a hundred years have been universally recognized as the standard of excellence.

TREE AND SHRUB SEEDS

We aim to have the most complete assortment of Native and Foreign Tree and Shrub Seeds, and have collected for us annually all the sorts that can be procured.

OUR CATALOGUE—the 103d successive annual edition—is the most complete, most reliable and most beautiful of American Garden Annuals. We Mail It Free.

J. M. THORBURN & CO.
36 Cortlandt Street New York

Biltmore Forest School

Biltmore, N. C.



Theoretical and practical instruction in all branches of applied forestry.

Course comprising twelve consecutive months can be entered at any time of the year—no vacations.

Object lessons within the mountain estate of George W. Vanderbilt, comprising 120,000 acres, where forestry has been practiced since 1895



For further information apply to

C. A. Schenck, Director

YALE FOREST SCHOOL NEW HAVEN, . . CONNECTICUT

The course of study in THE YALE FOREST SCHOOL covers a period of two years. Graduates of collegiate institutions of high standing are admitted as candidates for the degree of Master of Forestry.

The Summer School of Forestry is conducted at Milford, Pike County, Penna. The session in 1905 will open July 5th and continue seven weeks.

For further information address

Henry S. Graves, Director, New Haven, Conn.

